· JUNE 1950 ·

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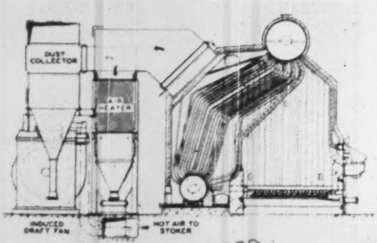


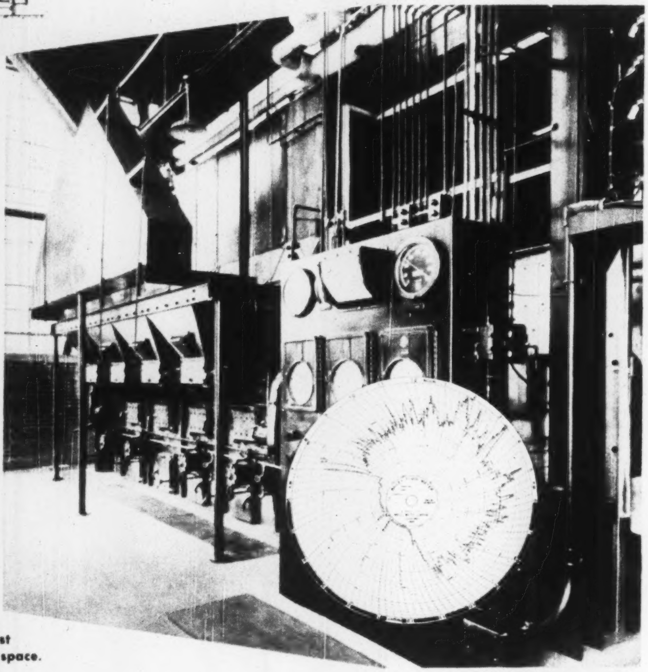
B&W Integral-Furnace Boiler, Type FF, at Hanes Dye and Finishing Company. Steam capacity is 40,000 lb. per hr. at 125 psi, with provision for future operation at 250 psi and with the addition of a superheater.

Another Example of B&W Engineering for Economy

...20% more steam

...37% less space

...20% fuel saving



Compact, single-level arrangement of boiler and auxiliary equipment with one-point control, provides utmost accessibility and ease of operation in minimum space.

Hanes Dye and Finishing Company, Winston-Salem, N. C., recently installed a single spreader-stoker-fired B&W Integral-Furnace Boiler, Type FF . . . in 37% less floor-space than was occupied by four existing units having 1/5 less total capacity. High efficiency is maintained over a wide range of coals, including low grades, resulting in estimated fuel savings of 20%. Operating over a daily load range of 12 to 1, the new boiler easily handles instantaneous load swings of 5 to 1 with close control of pressure and steady water level, as compared to pressure drops as much as 40 psi in the old units. Heavy maintenance costs experienced with the previous installation have been eliminated.

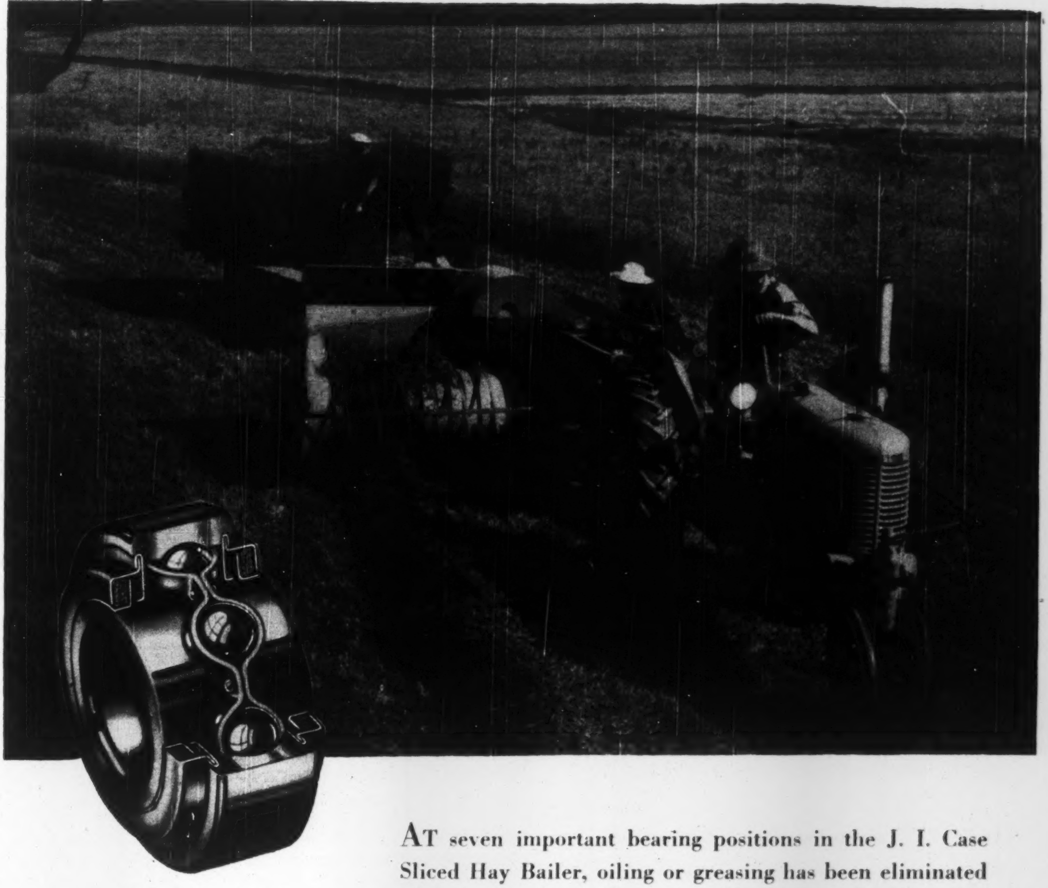
Dollars and cents benefits usually follow B&W's participation in boiler modernization for *any* type of plant. It will pay you, as it has so many other industrial, commercial, and institutional users, to investigate the modern B&W Integral-Furnace Boiler, Type FF, for steam capacities up to 60,000 lb. per hr. Start by writing for Bulletin G-64. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, New York.

B&W

BABCOCK & WILCOX

G-461

7 Greasing Points Eliminated . . .



Seven of these New Departure Lubricated-for-Life ball bearings are used in the feeder rollers and feeder apron.

AT seven important bearing positions in the J. I. Case Sliced Hay Bailer, oiling or greasing has been eliminated — maintenance by the operator has been reduced to precisely zero!

This labor and cost saving move is accomplished because these bearings are Sealed and Lubricated-for-Life ball bearings—originated and developed by New Departure—and—*"built to be forgotten"*.

nothing rolls like a ball... **NEW DEPARTURE BALL BEARINGS**

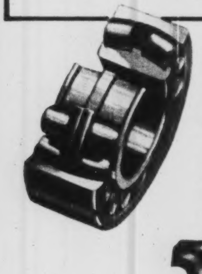
NEW DEPARTURE · Division of GENERAL MOTORS CORPORATION · BRISTOL, CONNECTICUT · BRANCHES IN ALL PRINCIPAL CITIES

MECHANICAL ENGINEERING, June, 1950, Vol. 72, No. 6. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price 75¢ a copy, $7.00 a year; to members and affiliates, 50¢ a copy, $4.00 a year. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

MORE TUNNELS
BREATHE MORE EASILY
BECAUSE OF SKF

TYPICAL SKF VEHICULAR TUNNEL INSTALLATIONS

Location	Number of Fans	Fan Manufacturer
LINCOLN TUNNEL, New York—South Tube	36	Buffalo Forge Company
LINCOLN TUNNEL, New York—North Tube	20	Westinghouse Electric Corp.—Sturtevant Division
QUEENS MIDTOWN TUNNEL, New York	46	Westinghouse Electric Corp.—Sturtevant Division
GEORGE WASHINGTON BRIDGE APPROACH TUNNEL, New York	8	Buffalo Forge Company
PENNSYLVANIA TURNPIKE—7 TUNNELS	26	Westinghouse Electric Corp.—Sturtevant Division
BANKHEAD TUNNEL, Mobile, Ala.	3	Clarage Fan Company
BROOKLYN BATTERY TUNNEL, New York	53	Westinghouse Electric Corp.—Sturtevant Division
BROOKLYN BATTERY APPROACH TUNNEL, New York	12	Westinghouse Electric Corp.—Sturtevant Division
WASHBURN TUNNEL, Houston, Texas	5	Westinghouse Electric Corp.—Sturtevant Division



SKF Spherical Roller Bearings have been specified for most of the major tunnel-fan installations because they're self-aligning . . . long-lived . . . require infrequent lubrication and inspection . . . give continuous trouble-free service under highly adverse conditions. *SKF Industries, Inc., Philadelphia 32, Pa., the Pioneers of the Deep Groove Ball Bearing, Spherical Roller Bearing, Self-Aligning Ball Bearing.* 7073

SKF
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SURFACE FINISH — PRODUCT UNIFORMITY — ENGINEERING SERVICE — FIELD SERVICE

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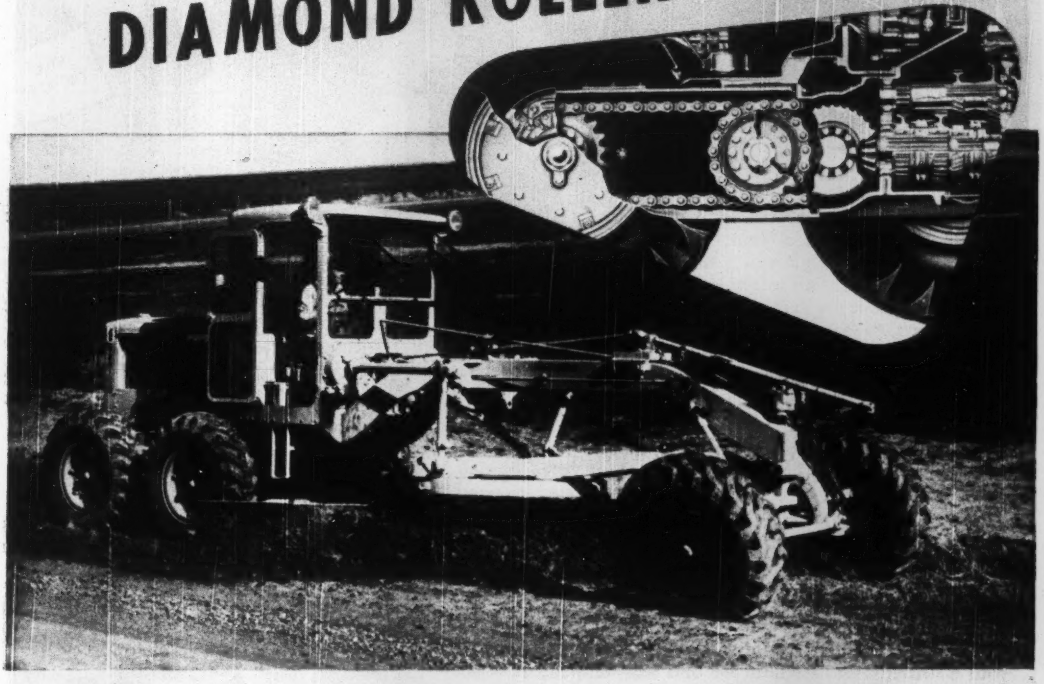
TRADE ◇ MARK

DIAMOND ROLLER CHAINS



● Incorporated in the efficient, trouble-proof tandem drive furnished on the many-purpose "Caterpillar" Diesel Motor Graders are Diamond 2" pitch Roller Chains of high strength and reliability. The tandem wheels on both sides are positively driven, the chains operating equally well even when slight flexing occurs.

Since the modernizing of road and construction machinery began, Diamond Roller Chains have given ample proof of their outstanding reserve strength, uniformity of quality, and long-life dependability.

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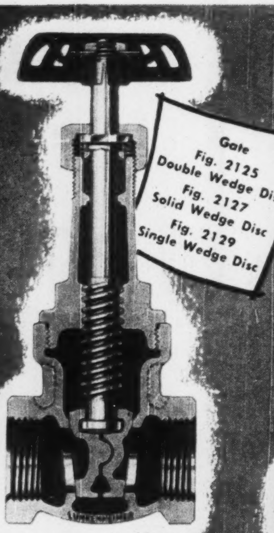
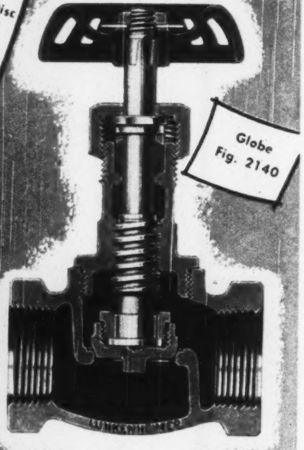

Gate
Fig. 2125
Double Wedge Disc
Fig. 2127
Solid Wedge Disc
Fig. 2129
Single Wedge Disc


Globe
Fig. 2140

IN THIS LINE OF VALVES you'll find just what you need to take care of your requirements for 125 lb. service. And you'll also get the inherent values that go into the design and manufacture of every Lunkenheimer product . . . the finest of materials, metallurgically tested and approved; sound engineering design; perfect alignment of parts; meticulous accuracy; craftsmanship guaranteed by skill and ripe experience; the most modern equipment to produce better, and ever better products.

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Angle
Fig. 2141
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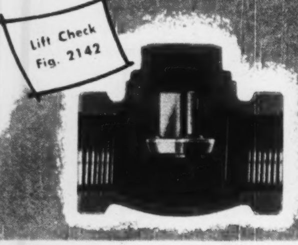
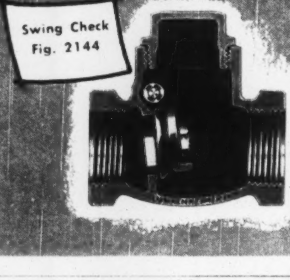
is stocking these 125 lb. S. P. Bronze Valves. Call upon him for your original equipment, replacement and repair valve requirements.


Lift Check
Fig. 2142


Swing Check
Fig. 2144

GEARS MUST BE GOOD FOR
"THE PERFORMANCE Leader!"
Union Special

UNION SPECIAL MACHINE CO. of Chicago stresses the *"performance leadership"* of their improved Lockstitch Sewing Machine pictured above. It offers—1. High production, 2. Fast acceleration, 3. Low maintenance, 4. Dependability, 5. Quality work, 6. Easy operation. Foremost among the parts responsible for the brilliant performance and long life of this excellent sewing equipment is G.S. Fractional Horsepower Gearing. Manufactured in production runs, with almost uncanny precision and uniformity, G.S. Small Gearing is specified by many of our country's most particular buyers from coast-to-coast. If your product calls for Gearing from 12 to 96 D.P. you are sure to benefit by submitting your needs to our skillful engineers. You see, we've been making *better* Fractional Horsepower Gearing *exclusively* for over 30 years! You can expect production runs uniformly made to the most exacting specifications from any type of materials, and *delivered on schedule.* Write today for suggestions, ideas and cost estimates. No obligation.

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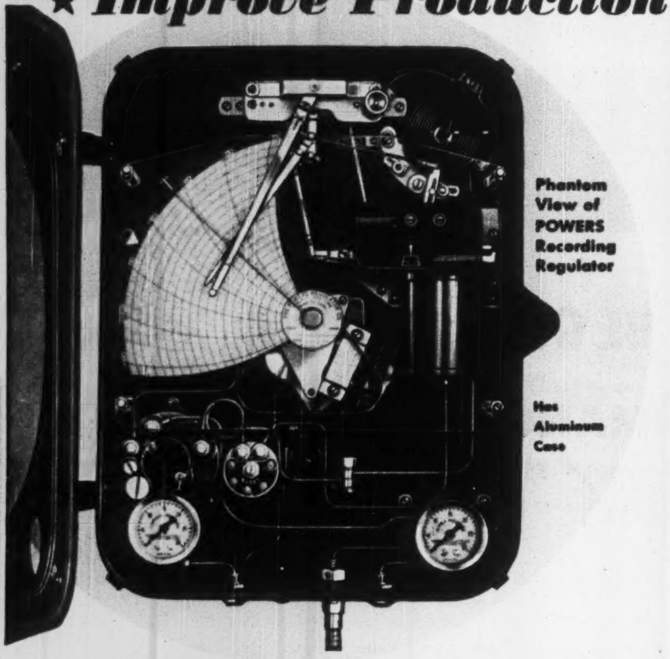
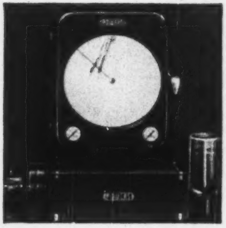
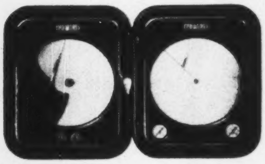


Phantom View of POWERS Recording Regulator

Has Aluminum Case



ABOVE: POWERS WET and DRY BULB RECORDING REGULATOR. Also available as a recorder only. Unit consists of two pen recording thermometer, water pan and motor blower causing sufficient circulation to give proper wet bulb readings.



ABOVE: POWERS TIME CYCLE RECORDING REGULATOR. Cam with cam follower operates steam control valve to correspond with any pre-determined time temperature schedule. Recording thermometer chart record provides a check on the operation of the control.

with precision control by—

POWERS

Air-Operated
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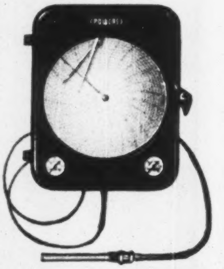
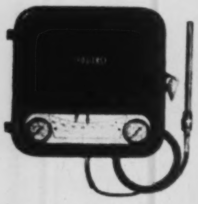
For TEMPERATURE • HUMIDITY • PRESSURE

End losses caused by OVER-heating of processes or operations requiring precise control. Install POWERS pneumatic regulators. Their accurate control helps to improve quality of products—speed up production and save steam wasted by overheating.





Variety of Models: Recording Thermometers; Recording Regulators; Indicating Regulators; Wet and Dry Bulb Recording Regulators; Time Cycle Recording Regulators; Master and Sub-Master Indicating and Recording Regulators, etc. *Write for Bulletin 370.*

For Better Temperature and Humidity Control and valuable aid in selecting the right instruments for your requirements—phone or write our nearest office. There's no obligation. The Powers Regulator Co., 2751 Greenview Ave., Chicago 14, Ill. • 231 E. 46th St., New York 18, N.Y. • 1808 W. Eighth St., Los Angeles 5, Calif.

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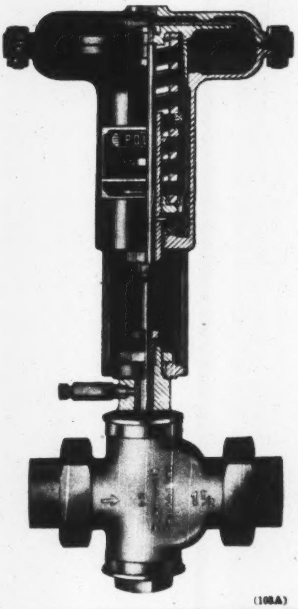

(108A)

ABOVE: POWERS FLOWRITE VALVE

INSTALLATION COSTS LOWERED!

RIC-WIL "PRE-BUILT" INSULATED PIPING

IS ACCURATE IN EVERY DETAIL

Careful pre-installation planning, plus accurate prefabrication of Ric-wiL units and accessories, greatly reduce installation time on either underground or overhead insulated piping. These savings on installation costs are later increased by the long high-efficiency and trouble-free life of Ric-wiL Insulated Piping Systems.

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Engineers and contractors the world over recognize the "built-in" accuracy and lasting quality of Ric-wiL products, each designed and built to do the most efficient job to fit any specific requirement.

Since 1910, thousands of Ric-wiL installations have produced maximum efficiency and protection on millions of feet of insulated piping systems. Constant product research and development, plus the company piping engineering service, make Ric-wiL truly "The Greatest Name in Insulated Piping".

RIC-WIL 40th YEAR DEPENDABLE INSULATED PIPING SYSTEMS 1910 · 1950

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INSULATED PIPING SYSTEMS

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**Initial pressures to 1450 psig
. . Back pressures to 300 psig**

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This new, high pressure single-stage turbine is more than an ordinary single-stage turbine in a "beefed up" high pressure casing. It is the *first* single-stage, mechanical drive turbine with all labyrinth shaft seals of the type generally used in large, multi-stage turbines especially designed for high pressure service.

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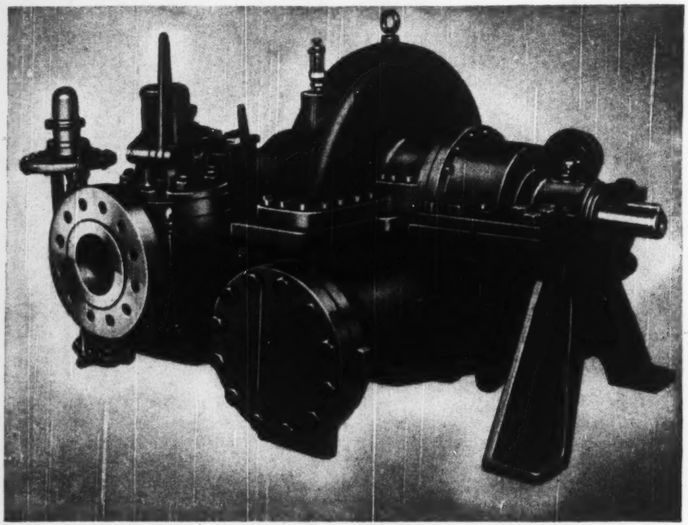

De Laval CP Turbine for high pressure service.

When you buy a De Laval CP Turbine you also get...

True center-line support—to provide for thermal expansion without disturbing shaft alignment.

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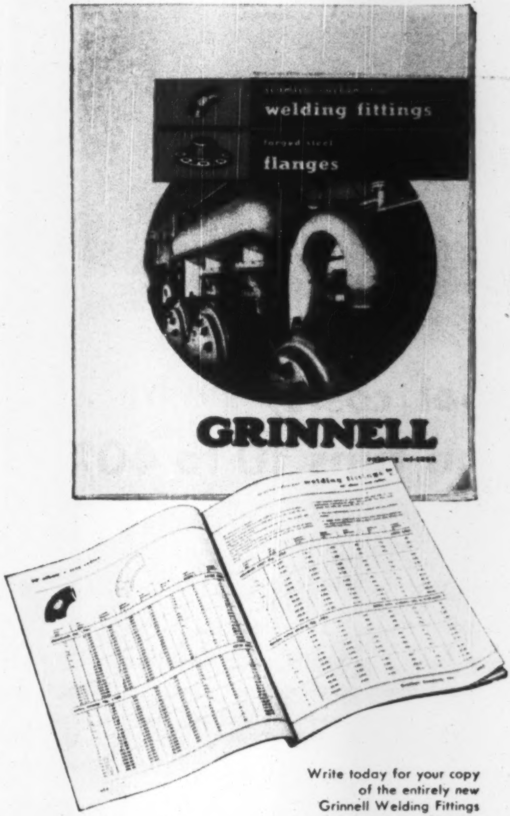

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- 180° returns . . . long radius, extra long radius, short radius, light gauge, special wall thicknesses
- tees . . . straight, reducing
- crosses
- reducers
- laterals
- lap joint stub ends
- caps
- saddles
- backing rings
- dimensional tolerances

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- slip-on . . . 150 to 2500 lbs.
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- threaded . . . 150 to 2500 lbs.
- blind . . . 150 to 2500 lbs.
- socket type . . . 150, 300, 600 lbs.
- reducing . . . threaded and slip-on: 150 to 2500 lbs.
- orifice . . . slip-on, welding neck; welding neck, ring joint; threaded: 300 to 1500 lbs.
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- minimum finished bores
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- facing dimensions of ring joint flanges
- thread standards and threading practice
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- physical and chemical requirements

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"Sems" maker cuts tool costs; lengthens production runs 10 to 40%

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Results such as these have occurred in hundreds of plants using L&N equipment. For information, or for suggestions on your specific problem, write Leeds & Northrup Co., 4963 Stenton Ave., Phila. 44, Penna.

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LEEDS & NORTHRUP CO.

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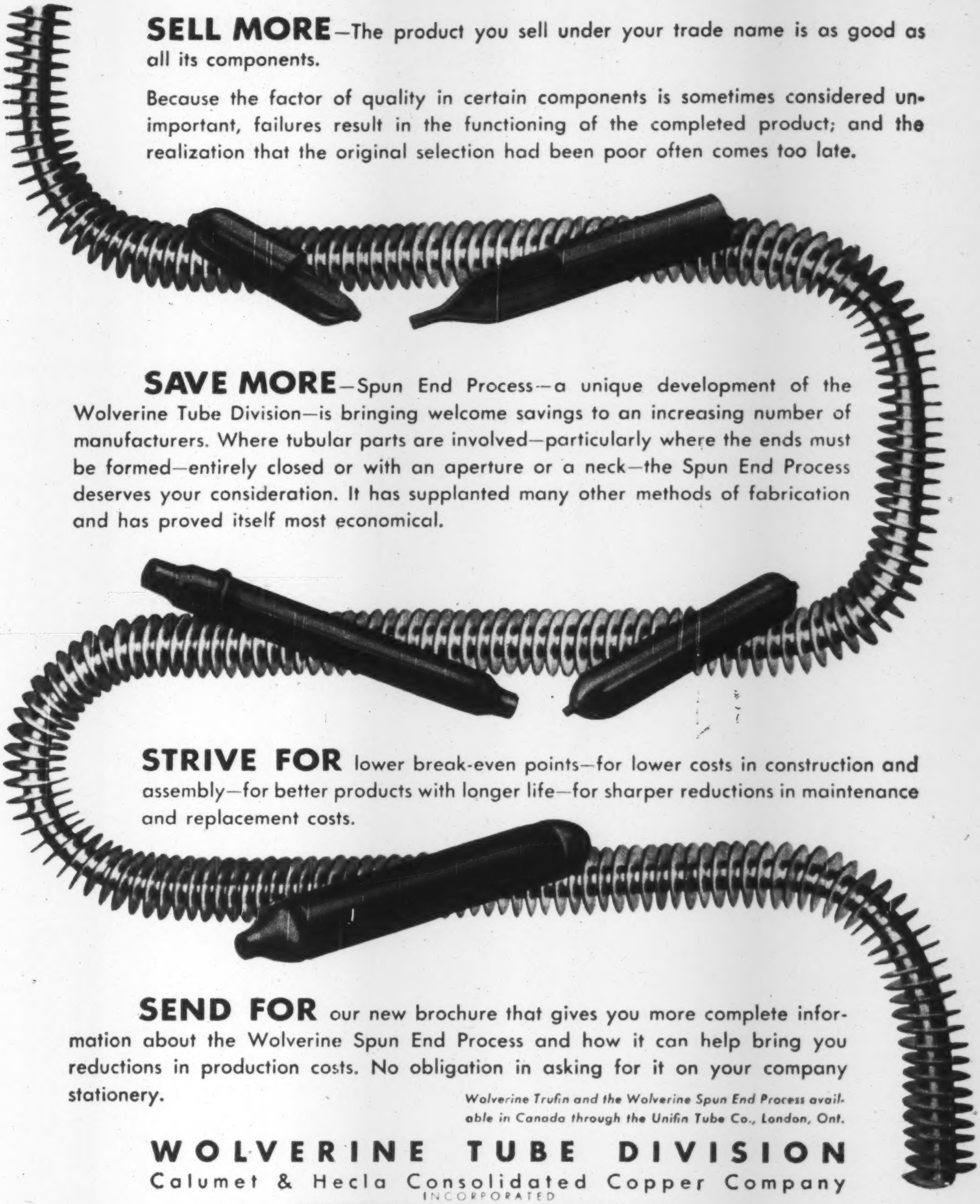

SELL MORE—The product you sell under your trade name is as good as all its components.

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PLANTS IN DETROIT AND DECATUR, ALA.
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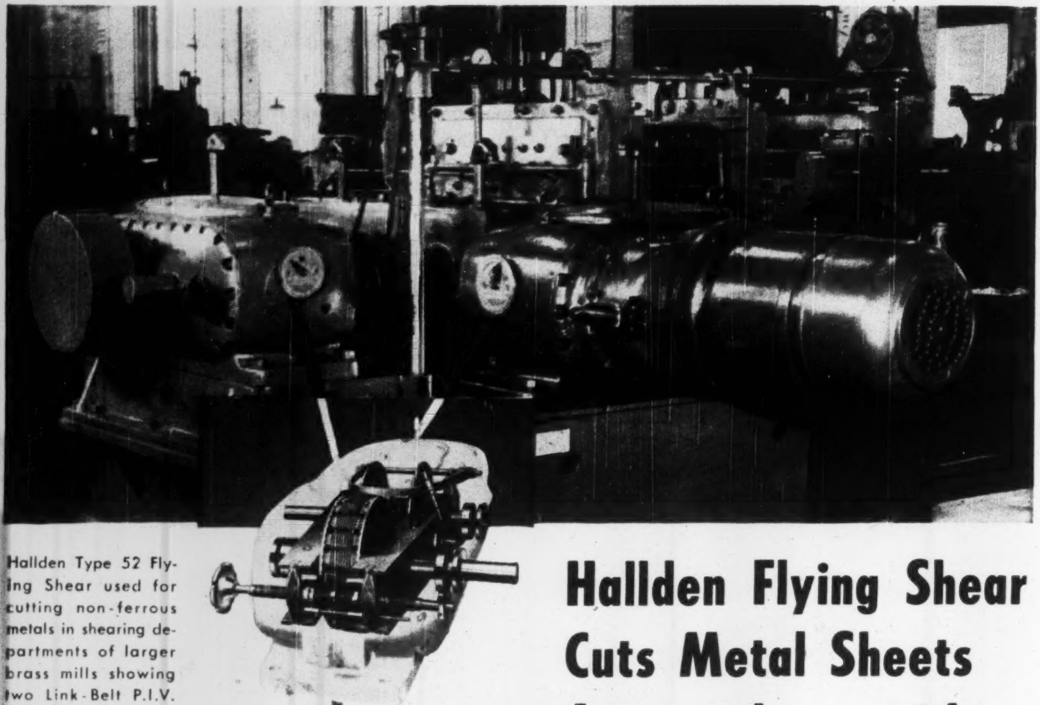

Hallden Type 52 Flying Shear used for cutting non-ferrous metals in shearing departments of larger brass mills showing two Link-Belt P.I.V. drives. Connection from hand wheel to machine-operator position provides remote control.

Hallden Flying Shear Cuts Metal Sheets Accurately . . . with

LINK-BELT P.I.V. DRIVES

Top accuracy without reduction of speed or flexibility — it's a have-your-cake-and-eat-it-too problem when you're after efficient volume production in metal shearing. And the problem's easily solved: Hallden engineers simply use Link-Belt P.I.V. variable speed drives in their combination levelers and flying shear machines.

In the Hallden Type 52, shown in this photograph, a continuously moving shear, synchronized with leveler rolls, cuts lengths from 12 inches to 12 feet, to an accuracy of 1/64 of an inch. Two Link-Belt P.I.V. drives vary the length of cut by regulating the speed of the strip in relation to the knife cycle. The P.I.V. drives provide infinitely variable speed regulation without slowing the knife cycle — which cuts as fast as 250 feet per minute.

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Available in eight types, up to 25 h.p.

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P.I.V. Variable Speed Drive

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...It can help you reduce cost at the point of assembly!

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DROP FORGING ASSOCIATION • 605 Hanna Building • Cleveland 15, Ohio

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metals" 1947 Edition.

Name________________ Position________

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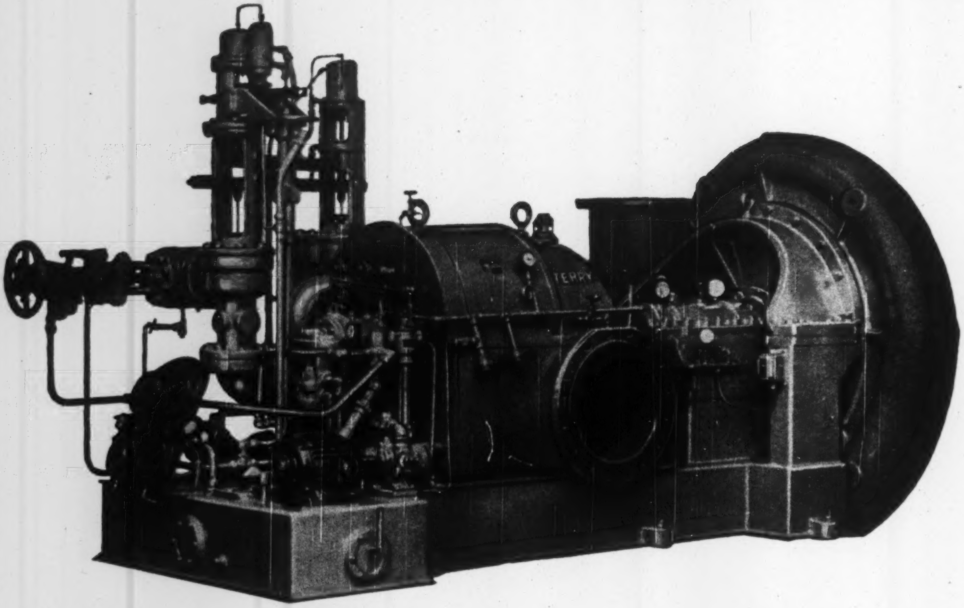
The TERRY TURBINE



SPECIAL PURPOSE TURBINE

FOR OPERATION UNDER ALL THESE CONDITIONS:

1. Straight, high-pressure, condensing
2. Straight, low-pressure, condensing — putting to work excess low-pressure steam.
3. Mixed pressure — using the low-pressure steam available, with only enough high-pressure steam required to drive the compressor
4. Condensing bleeder operation — providing clean, low-pressure steam for heating or process work

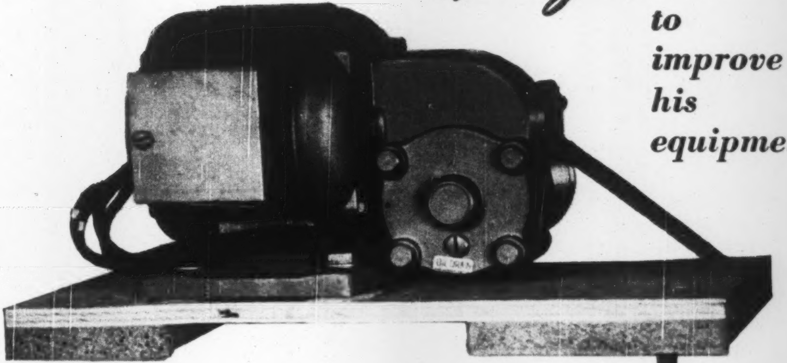
. . . and the speed under any of these conditions can be varied from 2800 to 4750 rpm.

This is but one example of many unusual combinations developed by Terry to meet out-of-the-ordinary requirements in turbines up to 2000 hp. Information on a special-purpose turbine for your specific requirements will be gladly furnished.

T1177

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

an imaginative photographer uses Spongex® cellular rubber to improve his equipment



Portable motor no longer "walks" away from its job

Jack Stock's portable motor "walked" away every time he put it to work. He mounted the motor on Spongex cellular rubber—now it stays on the job. Spongex absorbs the vibrations that give legs to portable motors.

Mr. Stock is in the commercial photography business; he doesn't manufacture motors. As a neighboring businessman in Shelton, he is well acquainted with the properties of Spongex cellular rubber. Now he mounts all his motors, stationary and portable, on Spongex.

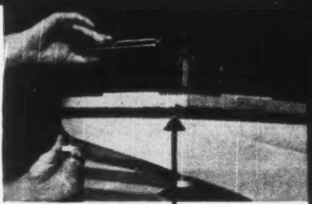
Smaller illustrations show other ways Spongex helps to produce better results in Mr. Stock's business.

Uniform, dustless, printing contact

In place of felt, Mr. Stock substituted Spongex on this photograph printer. Contact on film negative is more uniform, and the tendency of felt to pick up dust is avoided.

If you have a vibration, insulation, cushioning, gasketing, sealing or sound damping problem, think about *Spongex.* Cellular rubber does not become a "product" until you make it one in *your* application.

Technical Bulletin on Sponge Rubber available on request.



Seal against light and dust

In installing this copy camera attachment, custom made by Mr. Stock, on top of a photograph enlarger it was essential to block out dust and light. A Spongex gasket performs perfectly.

Resilient compression pad

This dry mounting press is fitted with a resilient Spongex cellular rubber base. Spongex equalizes pressure to mount photographs evenly and more securely on their backings.

SRp

The World's largest specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

301 Derby Place, Shelton, Conn.

"SAVES 2000 LBS. STEAM PER HOUR"

with Taylor Compressor Control

One of the largest refineries in the country reports that Taylor automatic compressor control with Speed Transmitter has saved them as much as 2000 lbs. steam per hour per compressor in the past year. It can do much the same for you.

Like all other process industries, for many years this refinery held compressor speeds within certain limits by manually adjusted governors—regardless of changes in process conditions.

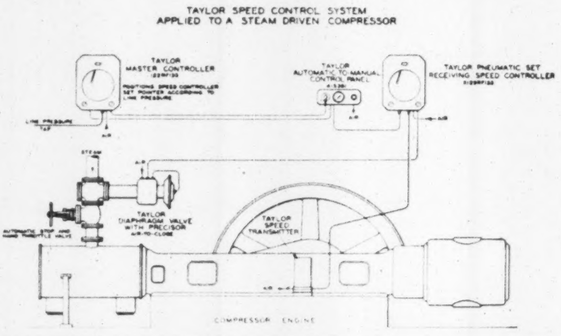
Now in the face of today's more rigid processing requirements, Taylor Compressor Control Systems combined with Speed Transmitters give you fully automatic control of compressors with direct relation to other variables in your process. These new compressor control systems were developed by Taylor Engineers working hand in hand for years with leading compressor manufacturers.

This all adds up to one important point. **When a compressor's function is closely controlled according to process requirements, substantial economies result from reduced fuel consumption as well as higher yields of quality end product.**

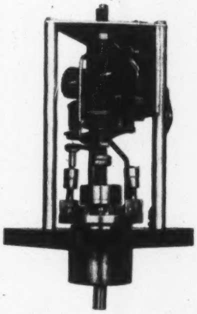
We can furnish a rugged, dependable control system for any type of drive. Ask your Taylor Field Engineer! Or write for **Bulletin 98207.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

• • •

Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.


TAYLOR SPEED CONTROL SYSTEM
APPLIED TO A STEAM DRIVEN COMPRESSOR
TAYLOR MASTER CONTROLLER
POSITIONS SPEED CONTROLLER SET POINTER ACCORDING TO LINE PRESSURE
LINE PRESSURE TAP
AIR
TAYLOR AUTOMATIC-TO-MANUAL CONTROL PANEL
AIR
TAYLOR PNEUMATIC SET RECEIVING SPEED CONTROLLER
AIR
STEAM
AIR
TAYLOR DIAPHRAGM VALVE WITH PRECISOR AIR-TO-CLOSE
AUTOMATIC STOP AND HAND THROTTLE VALVE
TAYLOR SPEED TRANSMITTER
AIR
COMPRESSOR ENGINE

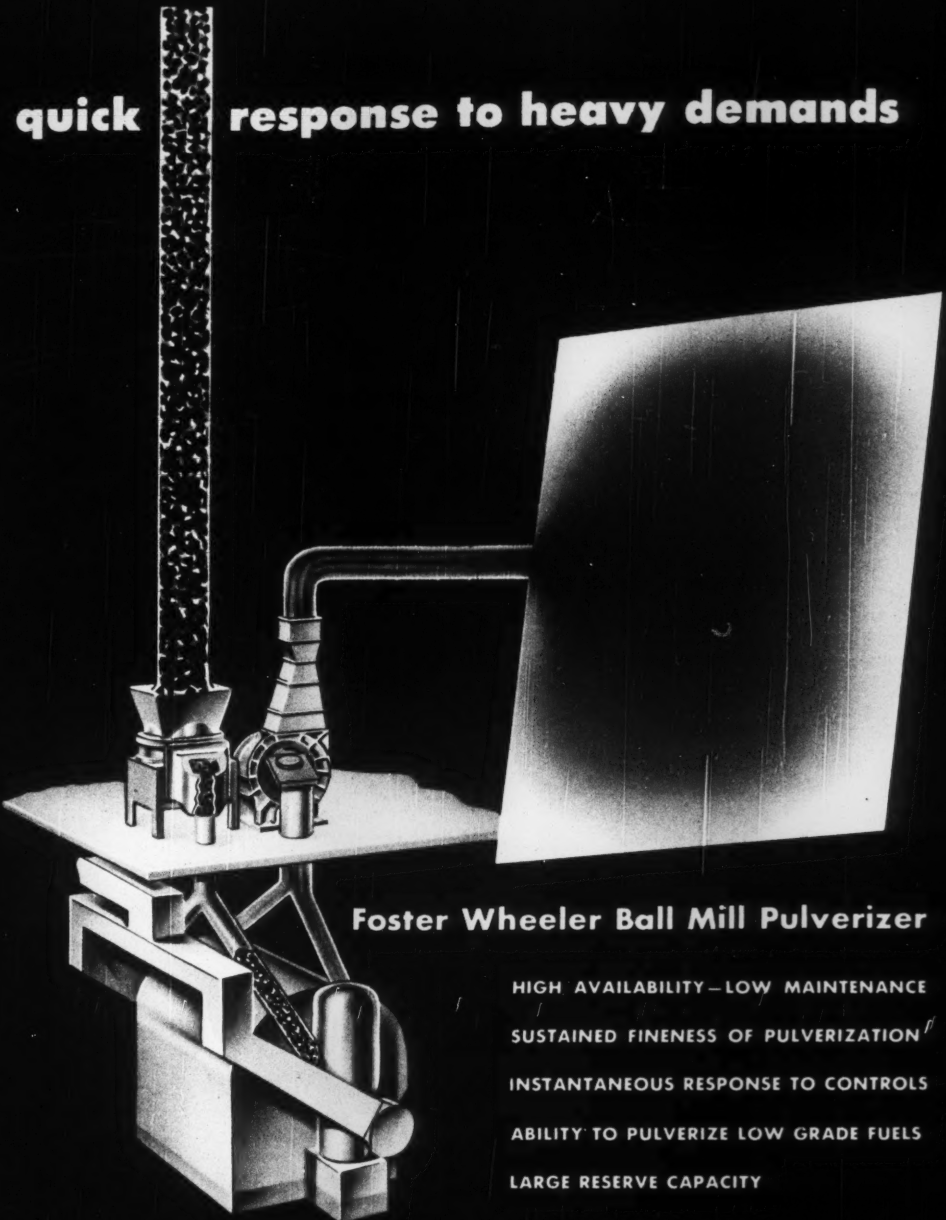
HERE'S HOW THE SPEED TRANSMITTER WORKS



Briefly, it's a dependable pneumatic force-balance instrument. Principal parts: drive shaft, rotating table, flyweights and pneumatic force-balance assembly. The full range of engine speed causes but slight change in the radial position of flyweights to effect full output air pressure change. Since radius is essentially constant, centrifugal force of flyweights increases as the square of the speed. Consequently the air pressure to the force-balance bellows and the receiver Speed Controller must vary as the square of the speed. Drawing above shows how Speed Transmitter teams up with Taylor Pressure Controller, Pneumatic Set Speed Controller and diaphragm control motor to maintain constant discharge pressure from a compressor on a process.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

quick response to heavy demands



Foster Wheeler Ball Mill Pulverizer

- HIGH AVAILABILITY—LOW MAINTENANCE
- SUSTAINED FINENESS OF PULVERIZATION
- INSTANTANEOUS RESPONSE TO CONTROLS
- ABILITY TO PULVERIZE LOW GRADE FUELS
- LARGE RESERVE CAPACITY

The basic qualities of dependability, responsiveness, and capacity for hard work . . . as symbolized by the prize workhorse . . . are also desirable in modern machinery. But it is the added element — *skilled engineering* — that removes us so distantly from the horse age and makes it possible to build machinery like the Foster Wheeler Ball Mill Pulverizer which pulverizes as much as 30 to 40 tons of coal per hour with instantaneous response to load demands.

For further information write to:

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

a small unit with a great background

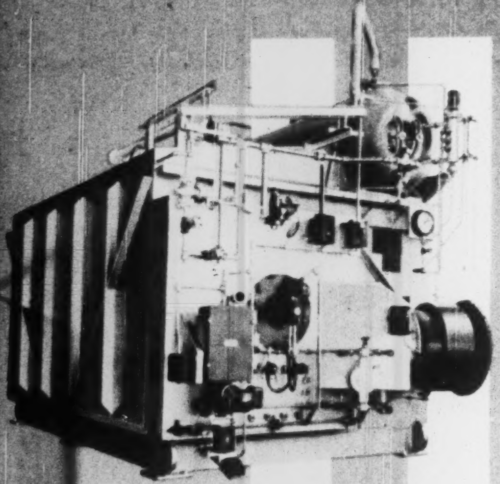
FOSTER WHEELER PACKAGE STEAM GENERATORS

water-tube units embodying the best features of central station and industrial steam plants

The average boiler horsepower per unit of 15,000 installations which were surveyed recently lies between 150 to 175 hp. These units were found to be operating at extremely low efficiencies with poorly coordinated equipment. There was also evidence that erection had been done by unskilled or semiskilled labor.

Could one of these installations be yours?

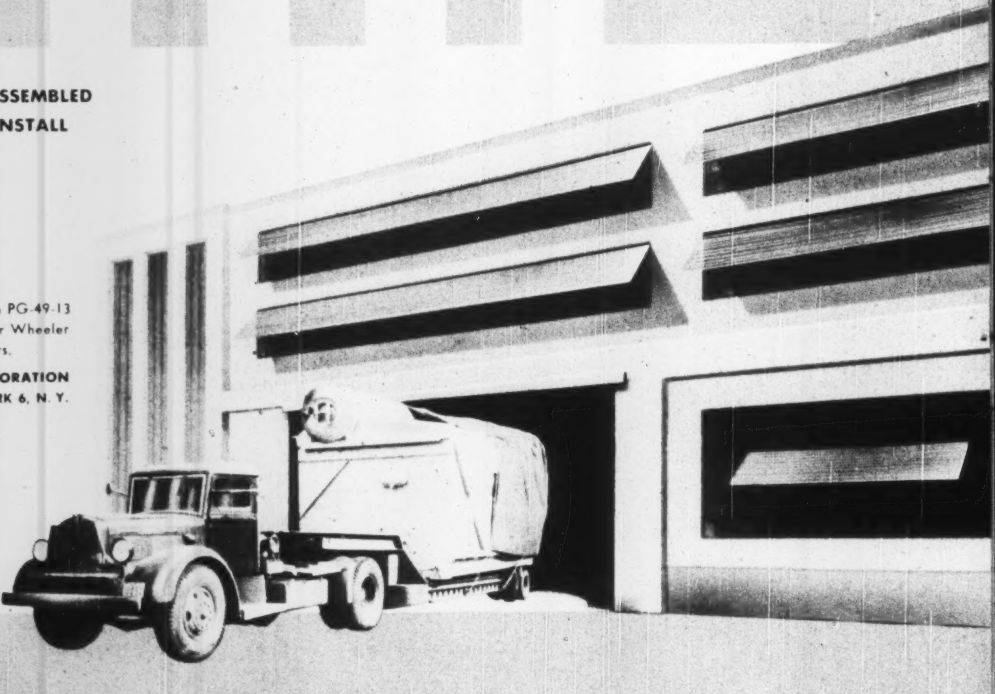
Provide for your present and future steam plant requirements by installing a scientifically integrated Foster Wheeler Package Steam Generator which *insures continuous steam output under widely fluctuating load demands at low cost and with a minimum of maintenance.* Exclusive Foster Wheeler features affecting casing, combustion controls, insulation and general structure are incorporated in this unique package unit.



FACTORY ASSEMBLED
READY TO INSTALL

Write for a copy of Bulletin PG-49-13 covering all types of Foster Wheeler Package Steam Generators.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y.



FOSTER WHEELER

BURROUGHS ADDING MACHINE COMPANY

have used DETROIT STOKERS for 33 years

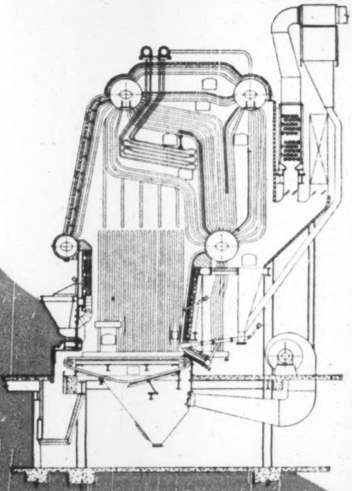
Burroughs Adding Machine Company Plant—Detroit, Michigan. Designed by Albert Kahn Associated Architects and Engineers.

NINE CONTRACTS FOR TWO PLANTS SINCE 1917

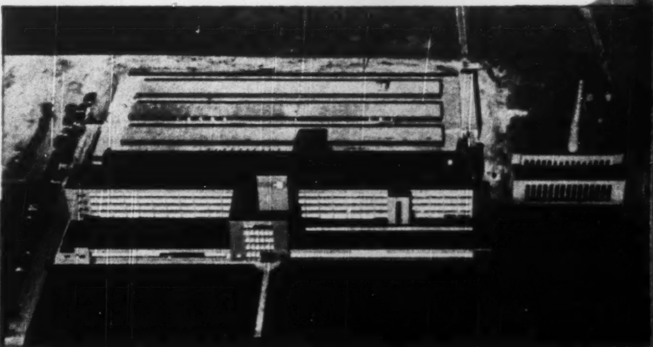
Economy of Operation The Keynote of Burroughs Buying Policy

As the Burroughs business has expanded through the years, calling for more capacity; and as fuel specifications have changed, they have continually modernized with Detroit Stokers. Burroughs Plants at Detroit and Plymouth, Michigan, use Detroit RotoGrate and RotoStokers exclusively. A wide range of bituminous coal and coke breeze is efficiently burned.

Why not modernize your plant to reduce steam costs. Our recommendations entail no obligation. Write for information.



Latest Burroughs Installation, Detroit RotoGrate Stoker with Union Iron Works Steam Generator.



Burroughs Adding Machine Company Plant—Plymouth, Michigan. Designed by Albert Kahn Associated Architects and Engineers.

THERE IS A TYPE AND SIZE OF DETROIT STOKER FOR EVERY INDUSTRIAL OR POWER NEED

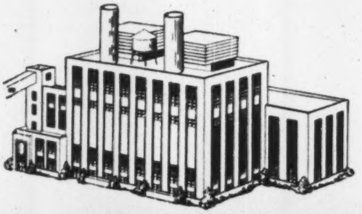
DETROIT STOKER COMPANY

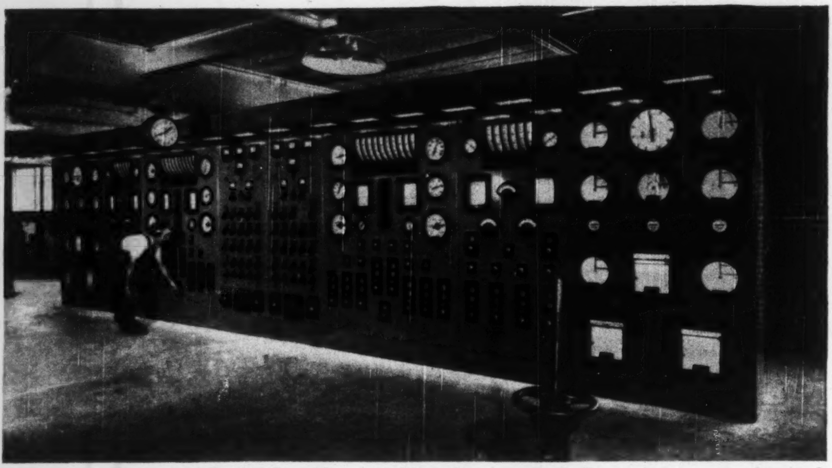
GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN
District Offices in Principal Cities . . . Works at Monroe, Michigan

DETROIT STOKERS

4166

● at the New GADSDEN Steam Plant
of the Alabama Power Company





On this Republic control board are mounted all gauges, meters and controls for operating each of the two boilers and their auxiliaries.

Efficiency HAS BEEN MADE *Automatic*

It is the policy of Alabama Power Company to generate, transmit and distribute electricity to its customers at the lowest cost consistent with good service.

When designing the new 120,000 kw. Gadsden Steam Plant, the Alabama Power Company, in keeping with this policy, incorporated proven engineering developments which contribute to economical power generation. High among these was REPUBLIC automatic boiler control.

Two steam generators, each with a capacity of 600,000 pounds of steam per hour, and operated at 875 psig. and 885°F, supply steam to the two turbines. Fuels used are natural gas or pulverized coal, either singly, or in combinations.

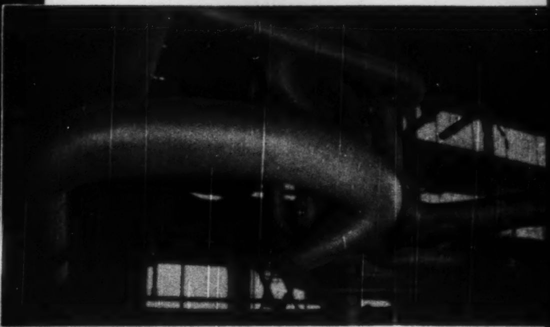
The REPUBLIC control board is made up of one electrical panel, one recorder panel, and two combustion control panels per boiler.

The REPUBLIC combustion control system receives its initial impulse from the main steam line through the master controller which establishes a pneumatic loading pressure proportional to the boiler load. The loading pressure is transmitted to the variable speed coal feeders, and to the gas flow valve when burning gas in combination with coal. This pressure is also transmitted to the air flow regulator. A corrector regulator provides means for maintaining the proper steam flow air flow relationship. Provision has been made for manually adjusting this ratio from the boiler panel.

The boiler feedwater pumps are equipped with REPUBLIC automatic minimum flow hand reset valves. These valves open when the flow through the pumps is 150 gpm or less and by-pass this amount of water to the deaerating heater.

For complete information on REPUBLIC automatic boiler control write for Data Book No. S-21.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

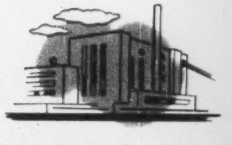


PIPING by MIDWEST

ANOTHER "First"

NEW SCHILLER STATION

First Complete Mercury-Unit Power Plant



The first installation of a mercury-unit power plant designed and built as a complete power generating unit . . . the Schiller Station of the Public Service Co. of New Hampshire at Portsmouth, N. H. is a notable achievement. When operating at designed rating of 40,000 kw and using Bunker C fuel oil, the heat rate is 9200 Btu per net kwhr.

The piping is by Midwest . . . fabricated and erected with undivided responsibility. "Firsts" are frequent with Midwest . . . have been throughout our more than four decades of experience with piping of all kinds. Midwest has grown up with modern high pressure and high temperature piping . . . through the years has achieved a wide reputation for better piping.

Whether you want a simple pipe bend, a series of complex prefabricated subassemblies, or a difficult piping job completely erected, Midwest has the facilities, the experience and the organization to meet every requirement. You will find it to your advantage to call upon Midwest whenever you need piping.

MIDWEST PIPING & SUPPLY CO., Inc.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Plants: St. Louis, Passaic, Los Angeles and South Boston • Sales Offices: New York 7—30 Church St. • Chicago 3—79 W. Monroe St. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. South Boston 27—426 First St.

4163

MIDWEST PIPING SERVICE IS NATION-WIDE

ST. LOUIS
LOS ANGELES
BOSTON
PASSAIC

4 Plants are Better Than 1

PIPING FABRICATORS AND CONTRACTORS

PRODUCTS HANDLING.

Nordstroms in a products pipe line pumping station.

Nordstrom Valves

NOW AUTOMATICALLY LUBRICATED WITH TRADE MARK **Hypermatic** PATENTS APPLIED FOR

Hypermatic lubricant makes tremendous improvement in Nordstrom valves. Being *energizable* it self-seals, self-feeds, keeping the valves in a 100% lubricated condition, for prevention of leakage and insuring most positive operation. Maintenance costs are cut to the minimum.

. . *infinitely safer* with NORDSTROMS

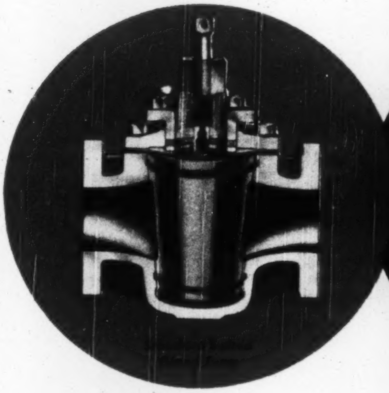
● In handling petroleum products you first consider *safety*. That calls for ever-tight valves, free from freezing, free to turn easily, positively sealed around the ports regardless of line pressure. Note how perfectly the Nordstrom design fits these specifications. The tapered plug is pressure lubricated, held tight on its unexposed seat by resilient means; the lubricated seat permits easy rotary turning of the plug, as contrasted to metal-to-metal unlubricated seats in common types; "Sealdport" lubrication surrounds each port to prevent leakage; the plug can be hydraulically jacked when required.

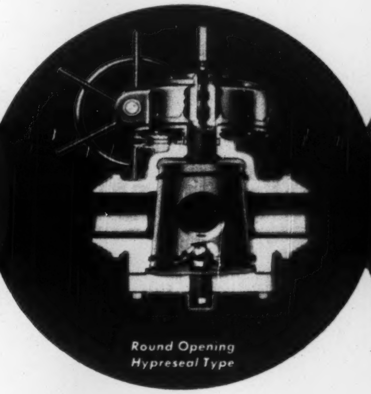
For handling gasoline, distillates, butane, propane and other petroleum products, Nordstroms have no equal. They keep upkeep down.

Put Nordstroms to ANY test

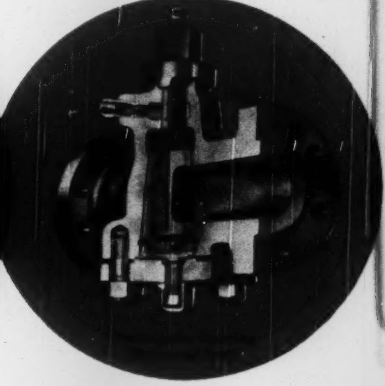
Install them, for test, side by side with any other type, check their operation, compare their performance . . . make a record of maintenance costs. You will find them to be tops in performance—and by far the most economical valves you have ever used. Successful operation of over 5,000,000 Nordstroms is proof of performance.

Nordstrom Valve Division—ROCKWELL MANUFACTURING COMPANY
400 North Lexington Avenue • Pittsburgh 8, Pennsylvania
Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa
. . . and leading Supply Houses • Export: Rockwell Manufacturing Co., International Division, 7701 Empire State Building, New York 1, N. Y.



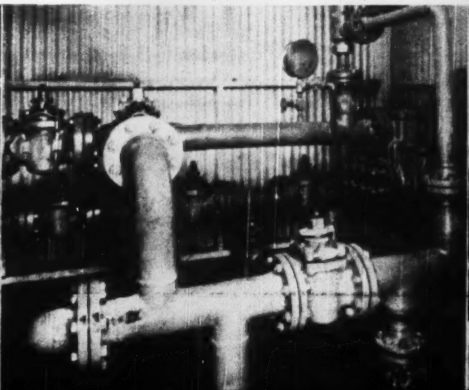


Round Opening
Hypreseal Type

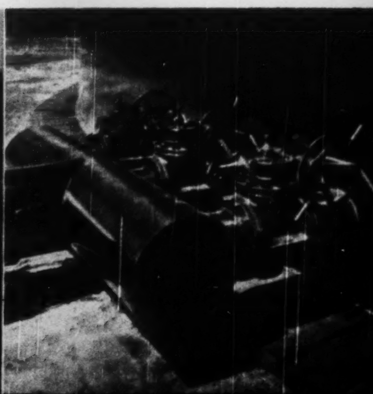


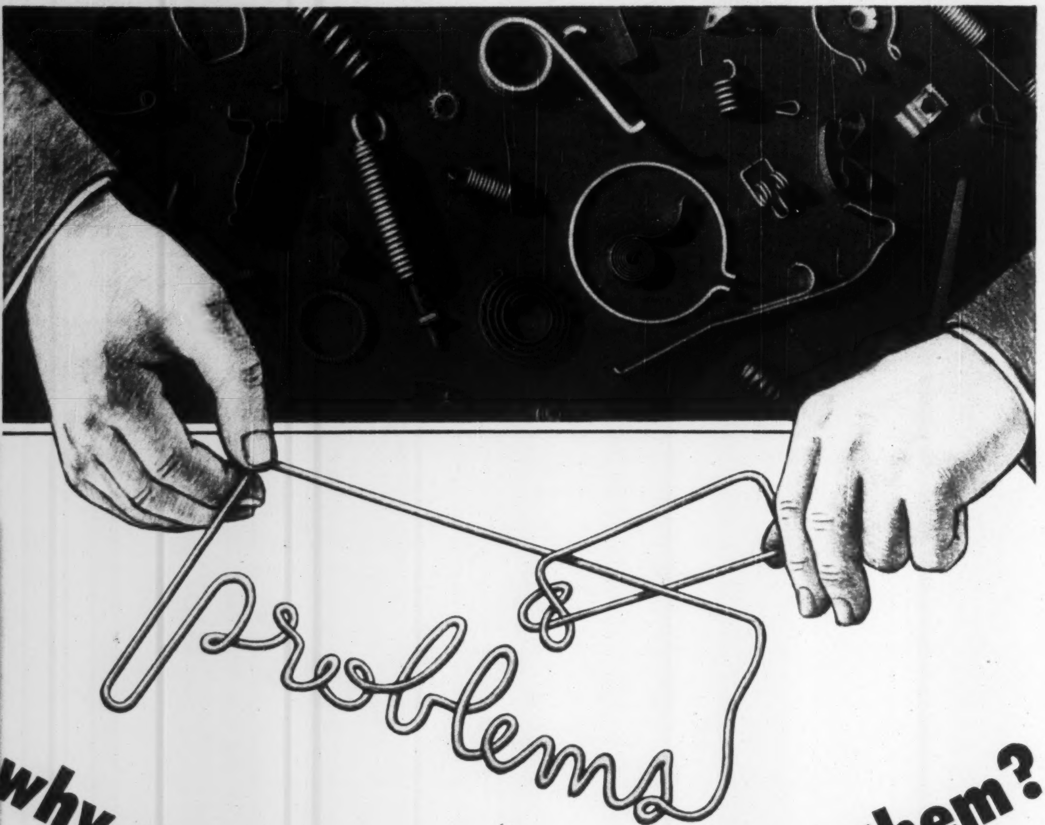
Nordstrom valves in a products pump station.

Nordstroms on products line in pump house.



Nordstroms on connections to gasoline storage tank.





why not let B·G·R untangle them?

What's yours? . . . stress, fatigue, space . . . small orders . . . deliveries . . . price? B-G-R applies a balance of scientific and practical skills to arrive at a spring solution favorable to all factors governing the specifications. Waste motion can be avoided in spring procurement. Let B-G-R show you how, on a specific spring problem.

BGR®

Barnes·Gibson·Raymond
Division of Associated Spring Corp.

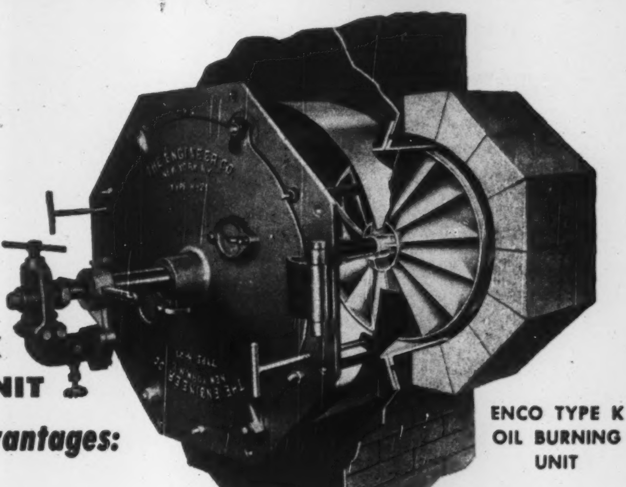
2 plants for spring service . . . ***Detroit 11, Michigan · Ann Arbor, Michigan***

NOW! *uniform combustion efficiency from high peaks to low loads with the*

ENCO TYPE K

OIL·GAS BURNER UNIT

HERE'S THE LATEST advance in burner units, designed to provide completely uniform combustion over the entire load range. The new ENCO Type K Oil-Gas Burner Unit is especially effective where steam demands swing sharply over short periods.



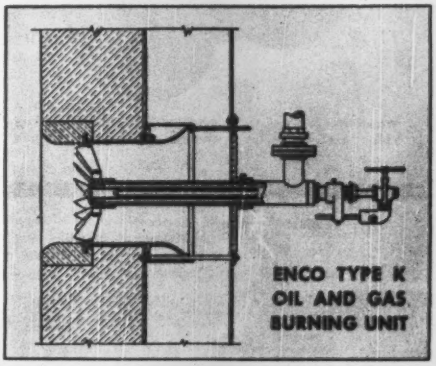
**ENCO TYPE K
OIL BURNING
UNIT**

THE ENCO TYPE K OIL·GAS BURNER UNIT

Offers These Additional Advantages:

1 Natural or forced draft operation.
2 Register draft tube designed for installation in 9", 13½", 18" and 22½" furnace walls.
3 No movable blades.
4 Air vanes provide fixed turbulence over entire load range. Adjustable for long or short flame.
5 Air volume control damper.
6 Hinged door for easy access to internal parts for inspection or removal.
7 Suitable for either steam or mechanical atomizing type oil atomizers.
8 Gas burner gun can be added for combination of gas and/or oil.
9 Comes in a wide range of sizes and capacities.

This new Type K Unit is the result of pioneering research, aimed to help you achieve more efficient, more economical boiler operation. Write today for further information, or see your local Enco Representative.



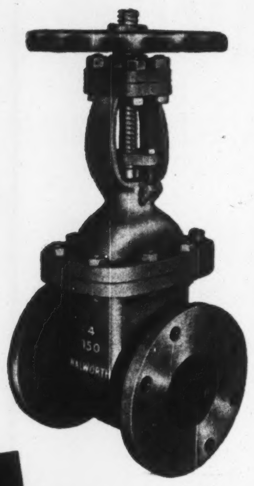
**ENCO TYPE K
OIL AND GAS
BURNING UNIT**

EC-479

THE ENGINEER COMPANY

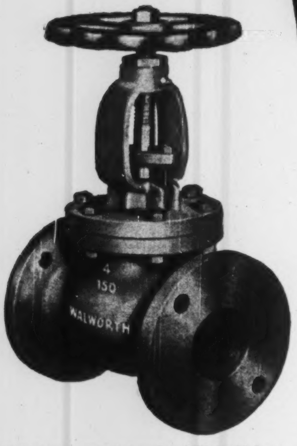
75 WEST STREET, NEW YORK 6, N. Y.

Newly Designed Walworth Valves to combat corrosion

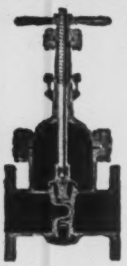


Walworth 150-pound Stainless Steel Gate Valve . . . available in sizes ½ to 3-inch, screwed; ½ to 12-inch, flanged.

Made of Stainless Steel
Monel · Nickel
Acid-resisting Bronze
Ni-resist



Walworth 150-pound Stainless Steel Globe Valve . . . available in sizes ½ to 3-inch, screwed; ½ to 6-inch, flanged.



Sectional view of Walworth 300-pound Stainless Steel Gate Valve . . . available in sizes 2 to 6-inch, flanged.

— ENGINEERED AND TESTED FOR TOUGH . . . HARD SERVICE

Walworth offers a comprehensive line of valves made of several cast stainless steels and special alloys for piping services where corrosion is a factor. These valves are available in Gate, Globe, Angle, Check, and Lubricated Plug types.

Gate, Globe and Angle Valves have outside screw and yoke construction, thus keeping the stem threads out of contact with the corrosive material in the line. They also have a two-piece bolted gland with ball-type gland follower to prevent binding the stem when packing bolts are tightened. Gland eye-bolts can be conveniently swung out of the way without danger of loss when the gland is lifted for repacking.

Gate Valves have taper seats with a unit consisting of two flat faced discs supported by a carrier on the end of the stem. The discs are of a proven ball-and-socket type. They are free to rotate and adjust themselves to the body seat angles, assuring tight seating with no possibility of sticking in any position.

For further information about Walworth's full line of corrosion-resistant valves, see your Walworth distributor.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

for Safety, Surety and Savings

...OPERATE DISTANT VALVES

by LIMITORQUE REMOTE CONTROL

Push-Button CONTROL

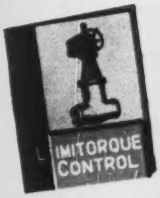
Shown above is a Crane Co. Type "S" Pressure-Seal Gate Valve.

The important safety factor afforded by *LimiTorque Remote Control* cannot be overstressed, because men do *not* have to go to high, low, dangerous or inaccessible locations to open and close valves. Further, *LimiTorque* prevents damage to seats, discs, stems, etc., because it *"automatically" shuts-off the power,* should an obstruction in closing occur.

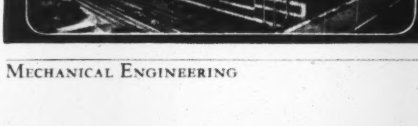
Think of the savings effected in time and money by eliminating men going from one valve to another (many of which are at distant locations)—not to mention the time required to shut or open each valve. *LimiTorque Remote Control* not only prevents this waste, but enables one man to merely *"push buttons"* and actually see on a panelboard whether the valves are open or closed.

Various *LimiTorques* are available for different requirements on all types of valves (globe, gate, butterfly, plug, etc.)—and, too, *LimiTorques* may be supplied for actuation by any power source, such as electricity, steam, water, gas, oil or air.

Thousands of *LimiTorques* are in use throughout the world, on land and sea. Be convinced; send for our 96-page catalog, L-48, and please use your Business Letterhead when requesting it.



Philadelphia Gear Works, INC.



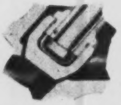
ERIE AVE. AND G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON
IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

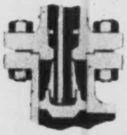
THESE EDWARD DESIGN FEATURES

ALL ARE "FIRSTS"... MANY ARE "EXCLUSIVES" ...EACH MEANS A BETTER VALVE

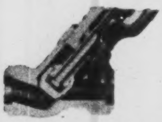
INCLINED STEM VALVES First to build inclined stem forged globe stop valves and check valves. Edward construction eliminates turbulence, cuts wear, reduces pressure drop 25 to 50 per cent.



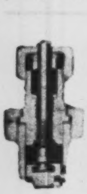
RADIUS STEM HEADS Radius of stem head assures application of closing load at center of disk. Curvature of inside of disk, in contact with stem head, centers disk for sure, tight seating.



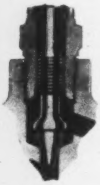
FOOLPROOF STEM BACKSEATS Spherical stem or disk nut surface contacts taper bonnet surface to make a pressure-tight backseat. Exclusive with Edward.



UNIVALVE* BONNET JOINT Patented leak-proof welded body-bonnet joint assures perfect alignment of working parts, permits disassembly if ever necessary.



EVALIZING* Exclusive Edward process electroplates parts with wear-resistant metallic lubricous material. Reduces wear and friction between internal valve parts 50 per cent or more. Ideal for temperature service.



TAPER THREAD BONNET JOINT
Taper threaded joint in small forged gage valves gives tight seal, withstands extreme pressures.

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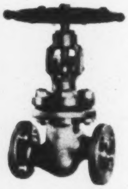
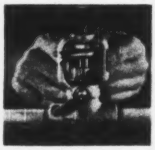
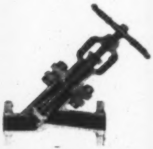


FORGED STEEL FLANGED VALVE DESIGN Edward designed first forged valves with symmetrical, uniform wall thickness. Eliminates thermal distortion and stress, cuts needless weight.

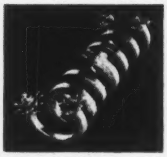


SWING BOLT RETAINER New type retainers keep packing gland swing bolts in place on integral forged support pins, yet out of way for easy repacking.

NO-BONNET INSTRUMENT VALVE No chance for bonnet joint leak with these compact all forged valves for toughest instrument line service.



WELDED-ON FLANGES Edward patented first valve constructions using welded flanges. Permits super strong drop forged bodies with thin walls and proper fibre flow.



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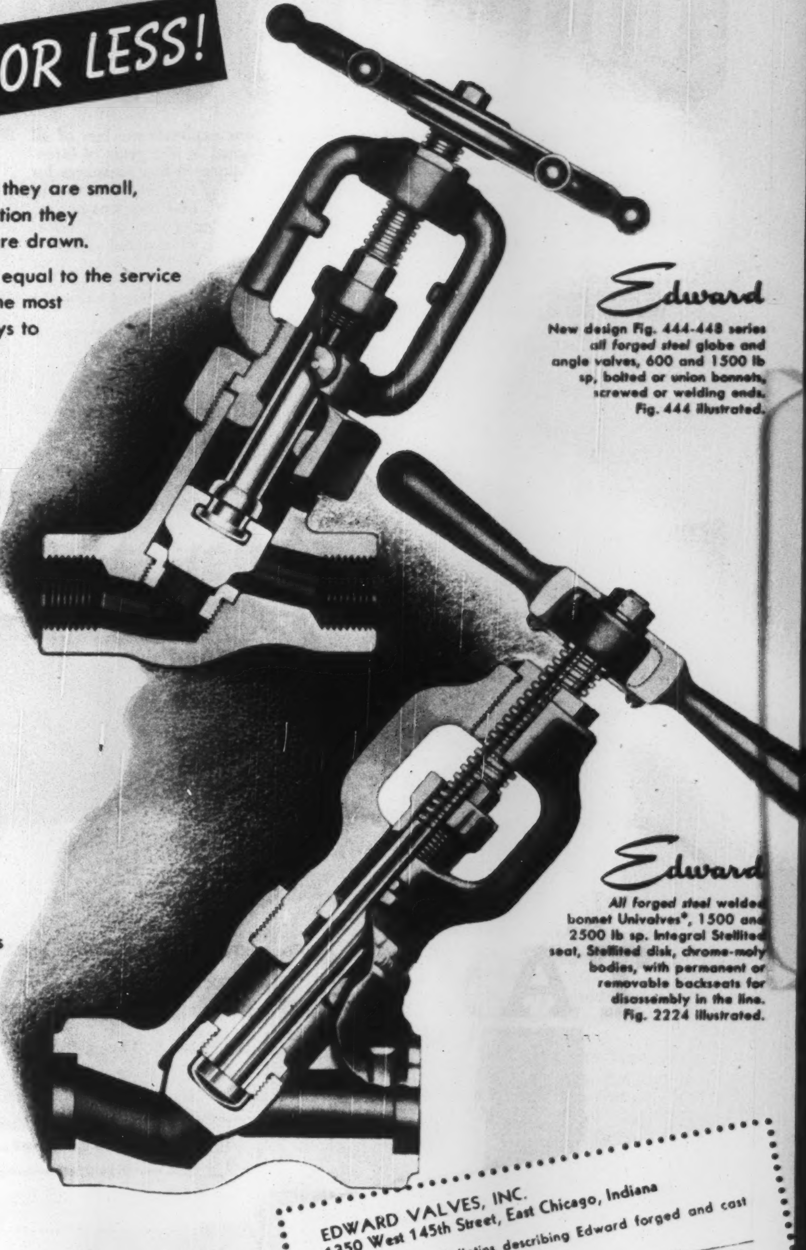

Edward

New design Fig. 444-448 series all forged steel globe and angle valves, 600 and 1500 lb sp, bolted or union bonnets, screwed or welding ends. Fig. 444 illustrated.

Edward

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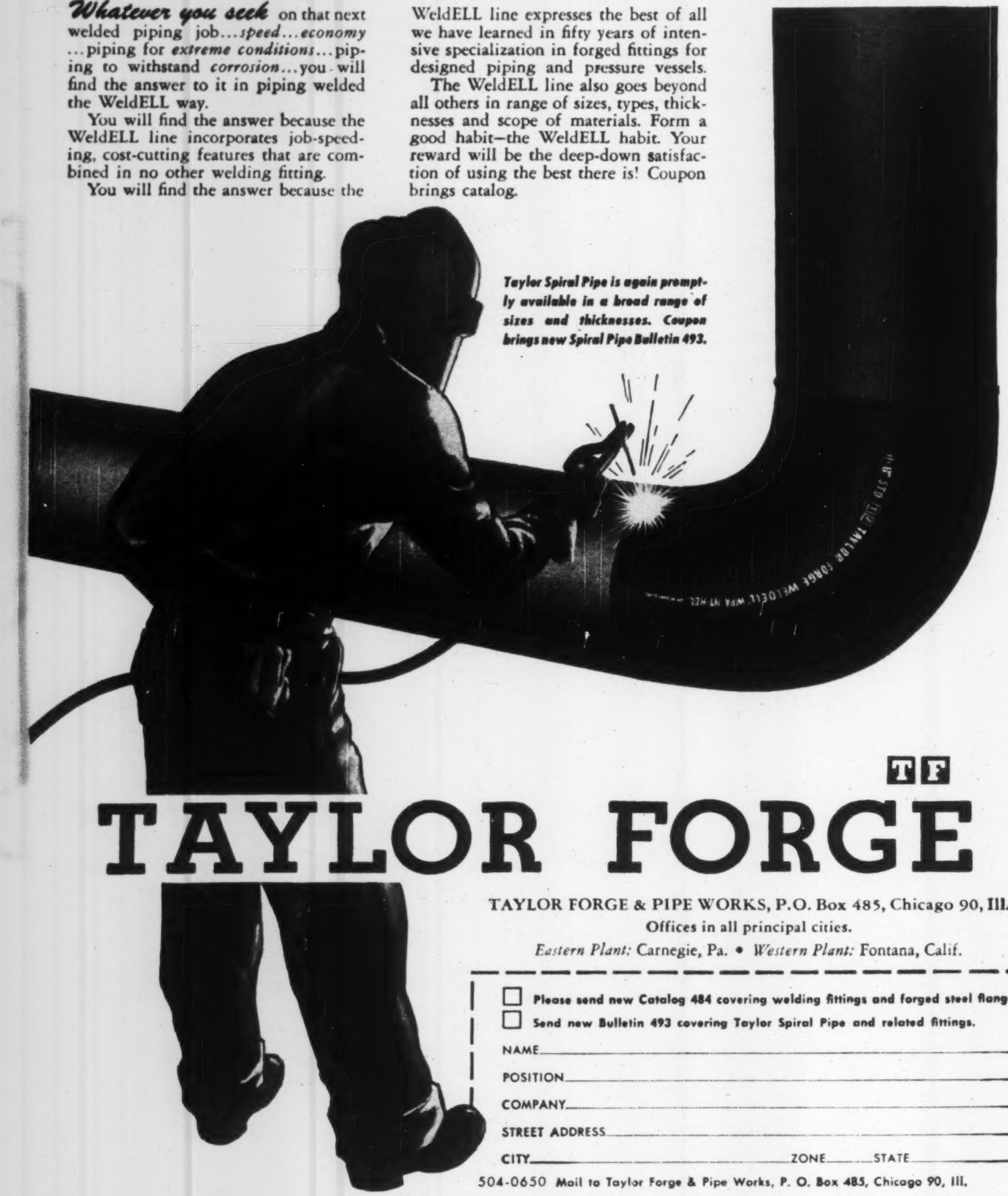

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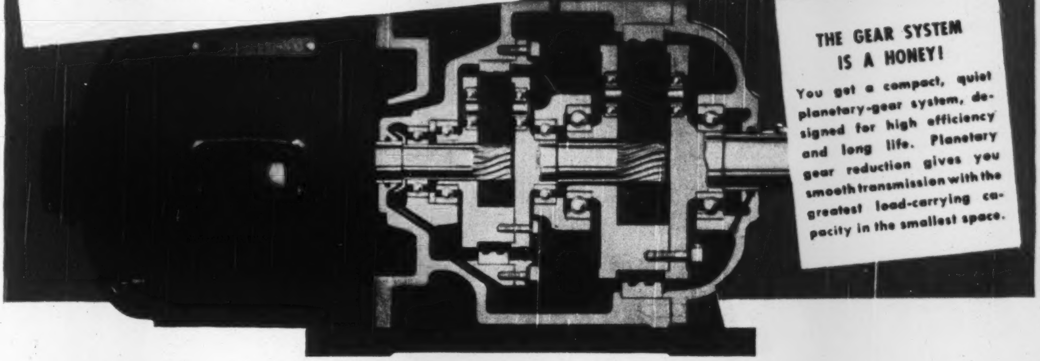

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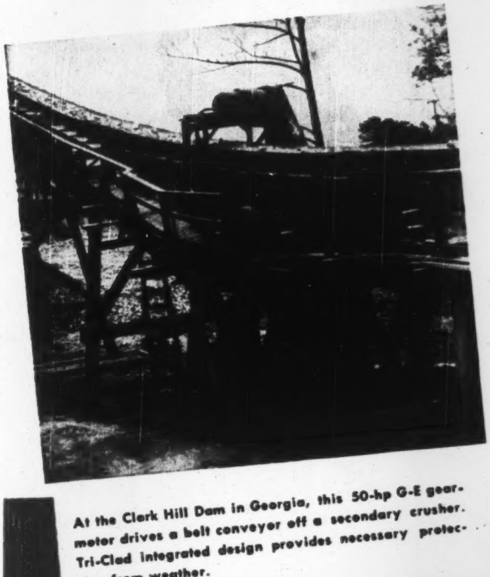

At the Clark Hill Dam in Georgia, this 50-hp G-E gear-motor drives a belt conveyor off a secondary crusher. Tri-Clad integrated design provides necessary protection from weather.

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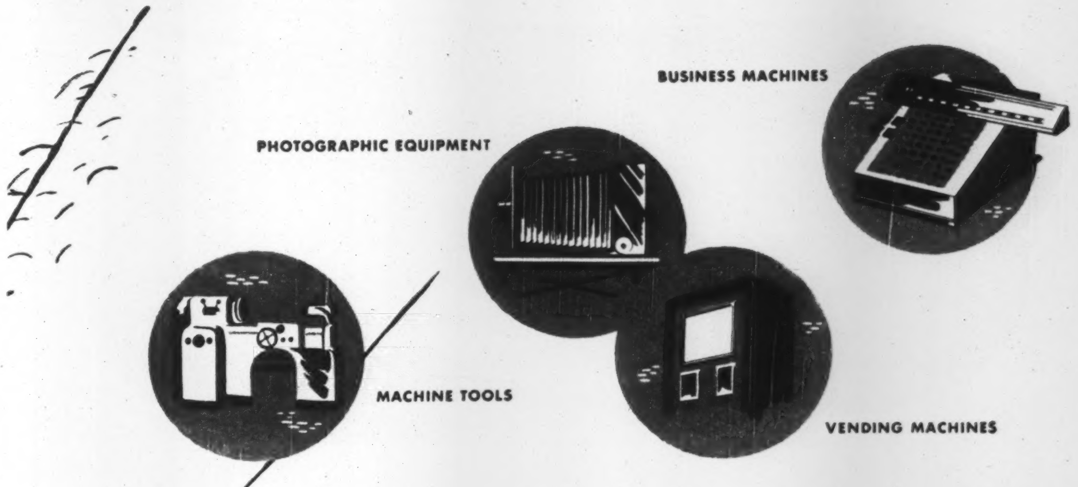

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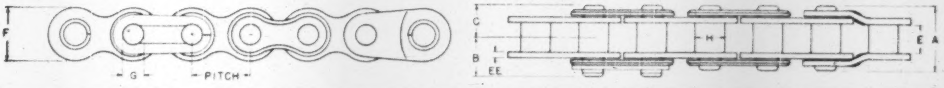
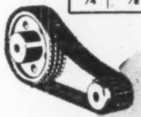
Hand power tools, juke boxes, animated displays, machine tools, photographic equipment, electronic equipment, television equipment, business machines, model equipment and many other types of high precision, small size equipment can be more efficiently designed with this new helping hand to the designer. In many larger types of equipment, too, this handy little chain can motivate intricate timing functions that must be designed into small space.

For all the facts, write Baldwin-Duckworth Division of Chain Belt Company, 363 Plainfield Street, Springfield 2, Massachusetts.



Principal Dimens.			LIST PRICES				DIMENSIONS — INCHES								
	Roller									Side Plate				
Pitch	Width E	Diam. H	Riveted Chain Per foot	Connecting Link Each	Assembled Roller Link Each	Offset Link Each	Overall Riveted A	From Pin End to C.L. B	From Pin Head to C.L. C	Thickness EE	Height F	Pin Diam. G	Average Ultimate Strength Lbs.	Average Weight per Foot Lbs.
¼	⅛	0.130	$1.10	$.14	$.10	$.40	0.31	0.19	0.15	0.030	0.23	.0905	875	.085



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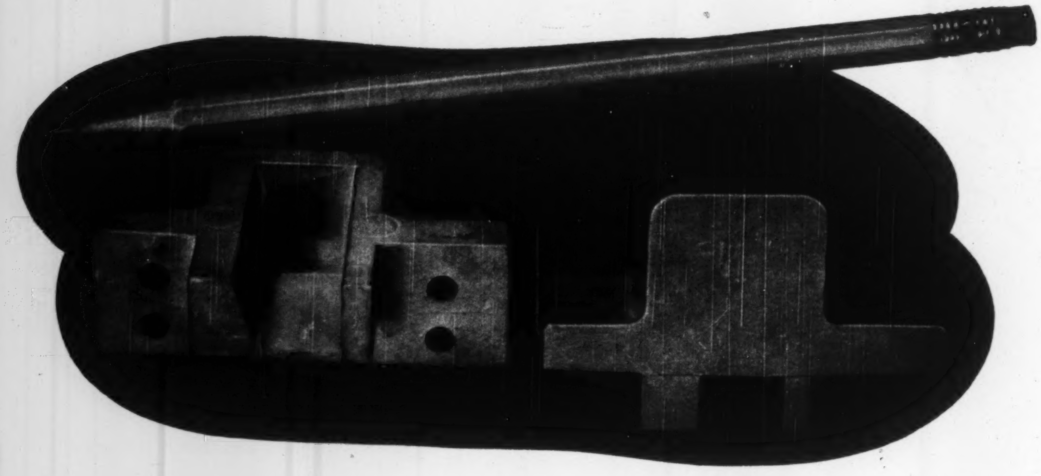

Design problem –solved in one operation

There is a story behind this picture worth several thousand dollars to one manufacturer. It may be worth a tidy sum to you, too.

Looking at the picture you see two life-size views of a Monel part used in quantity by this machinery manufacturer.

Just make a quick estimate as to what you would expect to pay for it. Consider the cost of the forging dies... broaching the slot... silver-soldering the back plate to close the end... drilling four bolt holes... and facing the back flange to fit the curved contour of a cylinder.

Something around $3.25, wouldn't you say?

Actually, this manufacturer is getting these parts exactly as you see them for just about a third less than you estimate.

How? By precision casting. One operation, one piece – and there you have the finished part all ready to bolt on the machine.

That is just one example of the variety of different parts now being produced in INCO's new Precision Casting Plant. The beauty of precision casting is the way its versatility opens up new possibilities for quantity-producing metal parts in designs too intricate to fabricate economically by conventional methods or downright impractical to produce by any other method.

IF YOU HAVE A PROBLEM *with a part whose cost seems too high... or a part where a precision casting might eliminate a number of operations (as with this latch-keeper)... or a part whose design cannot be practically worked out via other methods... send us a sample or blueprint, along with the approximate quantity needed. Within a few days you'll receive our frank answer telling you whether or not precision casting offers a better solution.*

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 72 NUMBER 6

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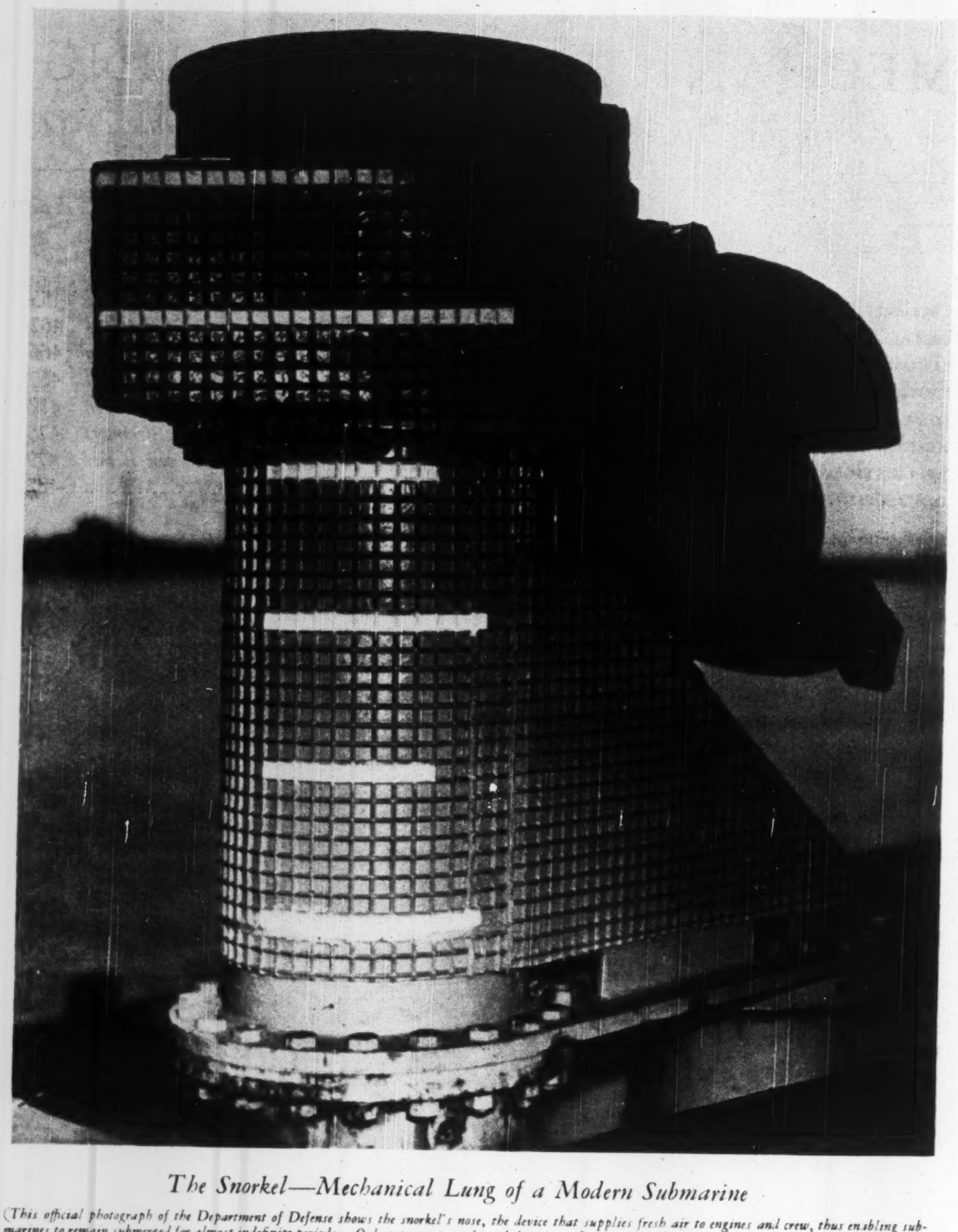

The Snorkel—Mechanical Lung of a Modern Submarine

(This official photograph of the Department of Defense shows the snorkel's nose, the device that supplies fresh air to engines and crew, thus enabling submarines to remain submerged for almost indefinite periods. Only topmost part of snorkel projects above water. For further details see page 490 of this issue.)

VOLUME 72
No. 6

MECHANICAL ENGINEERING

JUNE
1950

GEORGE A. STETSON, *Editor*

The Power Show

ENGINEERING has been profoundly influenced by trade fairs.

In the upsurge of the mechanic arts and the development of manufactures and steam power which characterized the closing quarter of the last century, the Centennial Exhibition which was held in Philadelphia in 1876 was an important event. It demonstrated to the western civilized world that America was ready to take its place as one of the great industrial nations of the earth. The genius for invention and production, which had been inherited from Great Britain and Western Europe, had flourished in the fruitful environment of the New World. With the unity of the States a decided issue, with the opening up of the West, with the development of the rich natural resources of the New World, and with the growing independence of America in serving its markets with manufactured goods, the Nation was ripe for that great increase in industry and productivity which was to mark it as the most prosperous and, in a material sense, the most advanced nation in satisfying the creature comforts of a vigorous and ambitious people. What it lacked in culture and refinement, it made up in a willingness to work hard with a courageous and pioneering spirit. Its political system was wholeheartedly devoted to democracy, and its social system admitted no caste or privileged class save that group which, through its own efforts and habits of thrift, had won for it the advantages of a bounteous environment.

One of the chief elements of that environment was sources of power. For the work which the youthful nation had to do in supplying the needs for manufactured goods that had to be satisfied if economic independence were to be maintained, making possible a high level of material prosperity, and spanning enormous distances by railroad and steamship if new frontiers were to be opened up, rich resources made accessible, and domestic and foreign trade established on a profitable basis, power was necessary. And at Philadelphia, power, dramatically symbolized by the giant Corliss engine, was a central attraction, and the electric dynamo an earnest of the future.

It was power that engaged a major share of the attention of the members of the youthful American Society of Mechanical Engineers. It was a broad field, originating in thermodynamics, fuel chemistry, and mechanics, and involving design, construction, test, operation, and transmission. It covered a rapidly expanding variety of furnaces, boilers, prime movers, pumps, transmission devices, and auxiliary equipment. Within a few years it was including the central station for the generation of electricity. It embraced fuels and combustion, and all the techniques and equipment pertaining thereto. It overlapped the fields of economics and industrial management and the handling of labor. It stimulated collateral development in the field of instruments, instrumentation, and control. Wherever one idea took root it was nourished by dozens of others in closely associated or remote areas of science and engineering, and it bore the fruit of dozens of new ideas and devices.

In the development of trade and industrial manufactures, we should not fail to give due credit to the stimulating educational influences of trade fairs and exhibitions. Not only do they open the eyes and fire the imagination and enthusiasm of the general public, creating a desire for new products and conveniences which the ingenuity of man devises, but they also serve in a similar manner to increase the productivity of the technicians and engineers whose best efforts are there exhibited. It was more than a coincidence that The American Society of Mechanical Engineers was organized on the heels of the Centennial at Philadelphia. For not only were the mechanical engineers of that period privileged to see in one place and at one time the products of the genius of their contemporaries and competitors, and to discover machines they themselves could put to good use, but the young men also, the engineers of the next generation, came under influences that awoke in them latent talents and the desire to enter so fascinating a field. And more recently, when specialization has given rise to power shows, machine-tool exhibitions, materials handling, instrument, chemical, tool engineering, aviation, automobile, motorboat, and a host of other shows, engineers have been richly rewarded by their attendance at these affairs because of the educational opportunities they have afforded. To mechanical engineers particularly the Power Show, held in New York on alternate years, has become an occasion few can afford to miss.

Traditionally, the New York Power Show has been held at the time of the Annual Meeting of The American Society of Mechanical Engineers. Both the Society and the Show have profited by this arrangement. The simultaneous occurrence of these two great national events has constituted a powerful incentive to engineers interested in power to visit New York during this Power Week. It has become a "must" for such persons. Hence the announcement made in this magazine some time ago that ASME will co-operate actively in the 1950 Power Show has great significance for engineers.

Official co-operation of ASME with the management of the 1950 Power Show will be financially advantageous to the Society and serve to cover some of the expense incurred in the operation of the 1950 ASME Annual Meeting. It lays on the Society the obligation of scheduling its technical sessions and other events in such a manner that engineers will be able to get maximum benefit from both events. Planning toward that end is in progress. The engineer who visits New York will be able to take in both the technical sessions of the ASME Annual Meeting devoted to power and related subjects and the Power Show. He will not only hear the latest developments discussed at those sessions, but he will be able to see the latest improvements in power apparatus at the Show. In this great convocation of engineers of the power field opportunities for meeting the leaders of technical progress and of design and manufacture will be abundant. The week of Nov. 27, 1950, should be heavily underscored on every power engineer's calendar.

Lantern Slides

THE American Society of Mechanical Engineers has been in the business of conducting technical meetings for almost three quarters of a century. To a great extent such meetings constitute a major portion of Society activities. Planning for meetings engages the full-time services of a number of persons and the part-time voluntary effort of hundreds of others. Experience gained over the years is passed on from group to group. Successful techniques are sifted out and perfected. Unsuccessful ones are blacklisted. Perfection is striven for, but attainment is not possible because every meeting is a new venture, involving new conditions and a new cast of characters. Constant effort is exerted to make each meeting better than the last one. But no matter how carefully the over-all plan is developed or how much attention is devoted to details, what happens when the audience has assembled and the chairman opens the session depends in no small degree on how the persons who present papers and offer discussion rise to their task. It is then that the audience learns how well prepared an author is and how competent he may be in presenting his ideas to them. For a period of an hour or so an author has the stage and the success of the session is in his hands. He is, perhaps, the most uncontrollable factor in a long series that are important to a successful session, for even an exceptional presiding officer backed up by most careful planning and scheduling and assisted by all the proper equipment in perfect order cannot save an audience completely from the annoying performance of a badly prepared author.

One of the most common and most annoying faults of an author is in having poor lantern slides. Since there is no excuse for using a poor lantern slide, except ignorance and inexperience, it would seem as though correction would be simply a matter of proper instruction. Indeed, such is the case. But the difficulty lies in lack of attention to such instruction as is offered. ASME, for example, attempts to make every author conscious of the desirability of using good lantern slides by providing instructions, based on ASA standards, that are to be found in the pamphlet "An ASME Paper." But unless authors read and heed, instructions are valueless.

Most engineers see enough bad lantern slides in the course of a year to warn them against repeating them. A little common sense should serve to guard against the most common mistakes. First of all, a lantern slide, projected on a screen, is not a drafting board or the page of a report or magazine, and it is not used under conditions like those that obtain in studying a blueprint or a book. The audience sees the projection of the slide for a matter of seconds or minutes. The first attempt is to get a general over-all idea of what the slide represents, and this is usually followed by reading whatever lettering and figures it may contain. Obviously, the minimum number of lines and characters should be used; the lines should stand out clearly and the lettering should be legible at a distance of at least 100 feet. Hence it will be found that few illustrations suitable for use in printed reports and magazines make good copy for lantern slides. Typewriting should be avoided as it practically never shows legibly on the screen. A diagrammatic sketch is better than a working drawing. If an author plans to use lantern slides, therefore, he should prepare his copy for that purpose and not rely on reproducing illustrations and extensive tables from his printed paper unless the copy he proposes to use is fairly simple and has been prepared with dual use in mind. Writing a paper and preparing it for presentation to an audience are separate tasks, each of which makes its own exacting demands.

Fewer poor lantern slides would be inflicted on engineering audiences if authors would hold a preview so they could see for themselves what the audience will see. Surely the average author has access to projection equipment and has enough kindly friends who will serve as a practice audience. The preview presentation of a technical paper has been demanded by some employers. If it were to become a standard practice, ASME meetings would be vastly improved and the authors themselves would come away from them with a profound sense of satisfaction at having done a creditable job.

Let's have no more poor lantern slides.

The End Crowns All

BAD as a lantern slide may be, its saving grace is its impermanence. A minute at the most and it disappears from the screen to linger only briefly in the minds of the audience as a horrible example. But not so the illustration that is published. Forever it stands as a reproach to the author who permitted it to deface his paper.

Instructions on the preparation of illustrations for publication are also to be found in the booklet "An ASME Paper." More detail is permissible in a printed illustration than in a lantern slide, but there is no excuse for confusion and unnecessary matter. A few dollars spent on proper illustrations is an insignificant portion of the expense of preparing a paper. Here, the end crowns all.

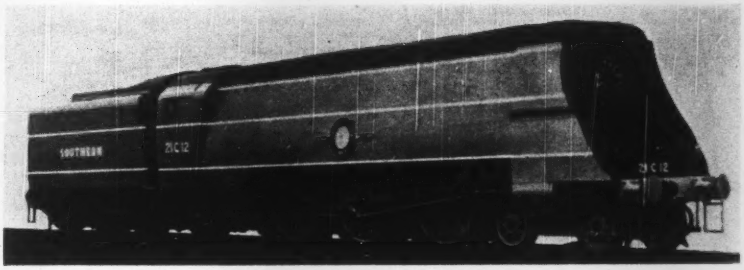

FIG. 1 MERCHANT NAVY CLASS ENGINE

Locomotive and Rolling-Stock Developments in Great Britain

By OLIVER VAUGHAN SNELL BULLEID

CONSULTING MECHANICAL ENGINEER, CORAS IOMPAIR EIREANN, DUBLIN, EIRE. LATELY CHIEF MECHANICAL ENGINEER OF THE SOUTHERN RAILWAY, ENGLAND. HONORARY MEMBER, ASME

LOCOMOTIVE AVAILABILITY MORE IMPORTANT THAN THERMAL EFFICIENCY

THE availability of the locomotives of a railway for service is more important than thermal efficiency, a more theoretical matter. As locomotive engineers, we are always trying to raise the efficiency of the engine, and there is still much to be done in this field.

The total cost, everything included, of operating 1 train-mile may be taken as approximately five times the cost of the fuel. If a 10 per cent improvement in thermal efficiency were to result in a 10 per cent reduction in fuel cost, the percentage reduction in the total cost of operating 1 train-mile would be 2 per cent. These figures explain the statement often heard that thermal efficiency never sold a steam locomotive. When, however, we consider the availability of a fleet of locomotives, substantial savings can be obtained by a small percentage increase in the number of locomotives available. In the case of the British Railways a reduction of 1 per cent in the number of locomotives out of service represents 200 additional locomotives available for service.

Consequently, for many years the improvement of the availability of the steam locomotive has been given much attention. Until a few years ago, 80 per cent was considered a reasonable percentage of engines available for the operating department, but now 85 per cent is expected and is, in fact, worked to.

An analysis of the 15 per cent "not available" gives the following breakdown:

Main workshop		Running-shed repairs	
(1)	(2)	(3)	(4)
Under repair	Waiting repairs	Under repair	Waiting repairs
4.8	1.6	7.6	1.0

Numbers (1) and (3) are dependent upon the total repair capacity and available staff, and the efficient use made thereof. Numbers (2) and (4) represent engines which stop themselves through breakdown or accident before they are due in shop, or engines waiting material such as cylinders or boilers. The numbers should be small.

BASIC REDESIGN FOR IMPROVED AVAILABILITY

While better equipment and facilities will speed up repairs, it is rather to the elimination of repairs that our attention should be directed, repairs that immobilize the locomotive. A basic redesign appears to be the only way this can be achieved.

The first major attempt to get substantial improvement was in the "Merchant Navy" engines, Fig. 1. These engines represent a completely new design, no regard being paid to any previous designs about which there was ample evidence to prove that improvement was desirable.

The three-cylinder engine provides us with the means of obviating dynamic increment, a valuable feature from the track point of view and for steady running. It involves a middle cylinder and an inside crank axle. Sufficient cases of overheating of the middle crank have been known to make it desirable to prevent this happening. This led to the enclosure of the whole of the inside motion so that it would be under continuous lubrication by pump, Fig. 2. A new valve gear was evolved, and the three sets for the three cylinders were all enclosed. The arrangement has eliminated overheating of the middle crank, and reduced the wear of the motion generally.

The boiler had welded steel inner and outer fireboxes fabricated by arc welding, and this type of box has reduced maintenance.

These engines were succeeded by the "West Country" class, a lightened version, the majority of the details being common to both classes. In all there are now 140 boilers in service with welded inner and outer fireboxes.

In these engines the axle-box guides are welded into the main frame, Fig. 3, thus eliminating the bolted fastenings. All cross stays, drag box, and trailer truck are fabricated with the same object of weight reduction in view but are bolted into position.

Based on an address prepared for the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 27–December 2, 1949, of The American Society of Mechanical Engineers.

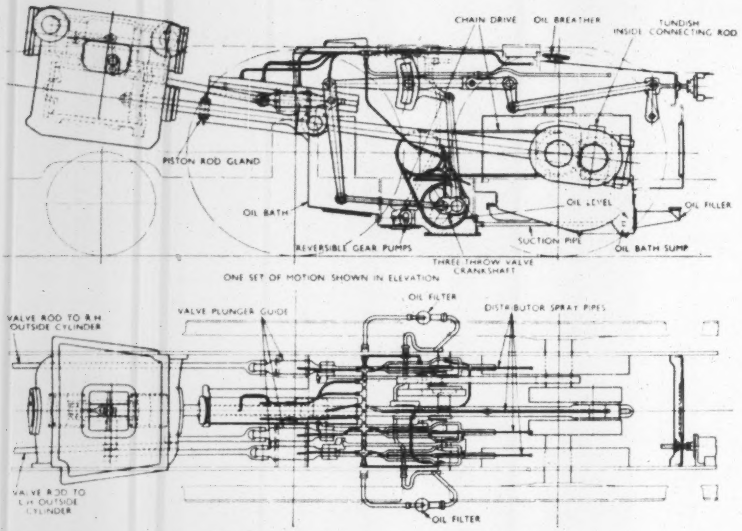

FIG. 2 MIDDLE MOTION, MERCHANT NAVY ENGINE

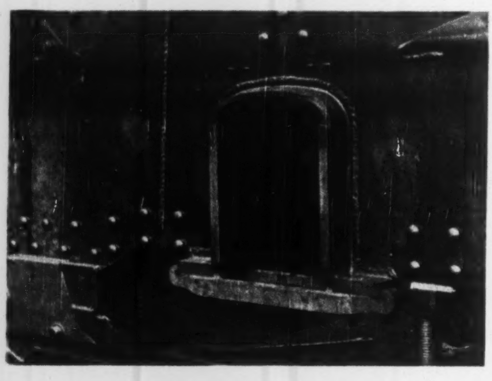

FIG. 3 WELDED AXLE-BOX GUIDES, WEST COUNTRY CLASS ENGINE

The development work incorporated in these two classes of engines has improved matters. The enclosed motion need not be examined more frequently than at the end of 40,000 miles.

The outside motion not being enclosed was not under continuous lubrication so that wear of these parts was not prevented nor overheating overcome. Maintenance had been reduced but not eliminated. Nuts, bolts, and set screws did slack back and other details became loose. Cylinder fastenings were not immune from trouble.

The General Steel Castings Corporation's one-piece bed is a notable achievement, and by eliminating loose fastenings, cylinders, and other gear gave us an example we could not ignore—it was a challenge we had to take up.

The latest boilers were an improvement as regards breakage of stays, but broken stays continued to be found.

The life of tubes was longer but pitting still took place. Corrosion of firebox plates was experienced.

T.I.A. WATER-TREATMENT SYSTEM ADAPTED

These defects led to the subject of water treatment being investigated again. Although water-treatment plants were installed, they were not in use continuously so that the engines were using raw water as well as treated. It was not appreciated that fully softened water was essential all the time. The best results were being obtained in France where the T.I.A. (*Traitement Intégral Armand*) system was in general use. The layout of this equipment is shown in Fig. 4.

I would like to pay a tribute to that great French engineer, the General Manager of the French National Railways, Monsieur Armand, to whom we owe this method of water softening.

Under this method of water treatment each engine carries its own water-softening plant, and the water is brought down to zero hardness. Each boiler is fitted with a hand-operated blowdown valve which is opened every 30 miles for 30 sec. Experience has shown that automatic blowing down was not effective as the action was not sufficiently violent to expel the mud collecting in the bottom of the water spaces.

The tender carries a tank containing the chemical solution to be added to the water, this chemical being determined from analyses of the waters the engine will use in the course of its operation. When the tank is filled the water rises inside a tube and compresses the air therein. This compressed air forces a predetermined volume of chemical from the chemical storage tank into the tender tank proper where it mixes with the water to be used by the engine.

An important feature in this system is that the engines are controlled at the sheds by men recruited from boilermakers or shed fitters and trained in water treatment. These men are directly controlled by the chief water-treatment engineer and not by the shed foremen.

The system is being applied to the whole of the Merchant Navy and West Country locomotives, a large number having been fitted with most satisfactory results. The boilers are free from scale and rust, the interiors are clean, the stays show the machine marks, and the plates are black on the water side.

In considering loss of availability, a major cause of loss of

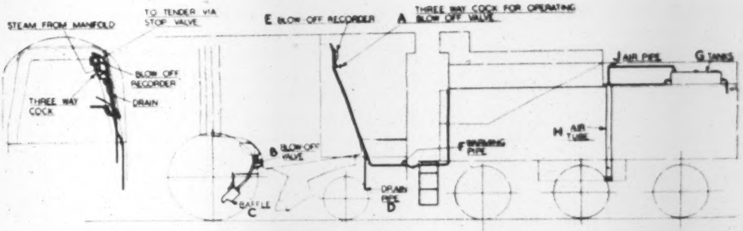

FIG. 4 T.I.A. WATER-TREATMENT SYSTEM

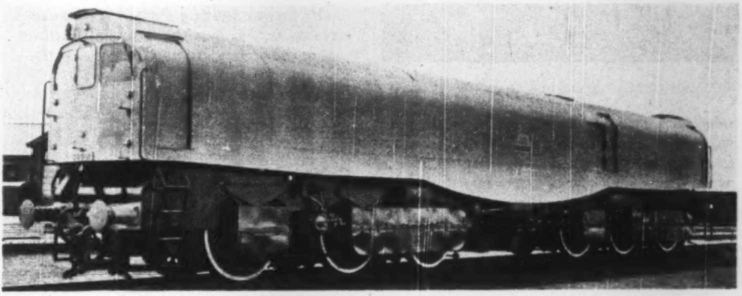

FIG. 5 LEADER CLASS ENGINE

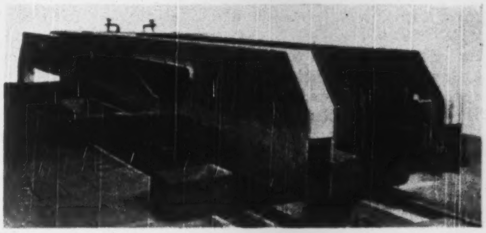

FIG. 6 BOGIE FRAME, LEADER CLASS

working days is the need to wash out the boilers every 7 to 10 days. The engines with the T.I.A. treatment are now running 60 days without washout, and the period could be extended were it not felt desirable to inspect the fireboxes at this interval. Washing out every 60 days instead of every 10 means an increase in availability of just over 10 per cent, an improvement of the greatest value, especially as it is accompanied by improved boiler conditions.

The boilers with this treatment will run, it is hoped, 4 years before requiring shop repairs.

It will be agreed, I trust, that some progress has been made when the enclosed motion has to be examined only at the end of each 40,000 miles, and the boiler requires washing out only every 60 days or even longer.

INTERESTING FEATURES OF "LEADER" CLASS LOCOMOTIVES DESCRIBED

We can now consider the latest engines, those of the "Leader" class, the first units of which are undergoing their experimental trials, Fig. 5. This locomotive has two separate power units of unusual design.

These engines are intended to meet certain specified requirements of the operating department and can be said to represent the size as regards power needed to work the majority of trains in England. Had these engines been intended for long runs, as on regions other than the Southern, they would have been fitted with water pickup gear and more coal carried.

These engines have been designed with the object of providing the motive-power department with an engine that would require the minimum of attention in the running sheds or depots, an engine able to work all classes of trains and having an unusually high availability.

The intention with regard to repair or major attention being required to either bogie was to run the bogie from beneath the main structure and replace it by another bogie retained as a spare. To enable this feature to be economically sound, it will require a sufficiently large fleet of these engines being constructed to justify the scheme. It cannot be doubted that when such a scheme is put into operation it will greatly increase the availability of the locomotives, as it is anticipated the upper structure and boiler will not require major repairs for many years.

The design is such that the usual preparation by a driver is not now needed so that the engine is ready for traffic at short notice. The engines have also been made suitable for operation by any set of men and need not be kept in the hands of a limited number of sets of enginemen.

They were intended originally to be oil-fired when distant control would have been simple. They could also be readily arranged with automatic stoker firing. With hand firing a fireman would be required at each firebox but the control of the second or other engine could be brought under one driver without undue complication.

These engines are of the $C_0 + C_0$ type and have two six-wheeled bolsterless power bogies which support the main frames.

The main features which are expected to improve the availability may be listed as follows:

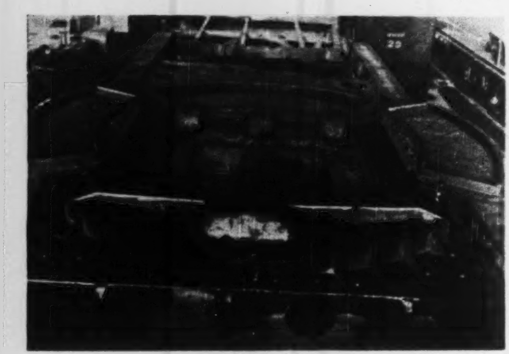

FIG. 7 BOGIE FRAME, LEADER CLASS

All-Welded Construction. The bogie side frames are hollow, and fabricated head stocks, cylinder block, and cross-stays are welded to them, forming a monoblock, Fig. 6. The main frame is fabricated by arc welding and carries the water tanks, the coal bunker, cross-members supporting the boiler and other stretchers, all of which are welded to it. The grate and ashpan are carried by the main frame as are the end cabs and casings.

The outer headstocks carry the buffing and drawgear, and the inner headstocks each carry two vacuum brake cylinders.

The bogies are able to rotate around segments secured underneath the main frame, Fig. 7. The bearing springs are located inside the bogie frames directly above the roller-bearing axle boxes with circular pedestals in place of the usual flat guides.

All Moving Parts Under Continuous Lubrication. The entire engine is enclosed and under continuous flood lubrication from a common sump on each bogie. The drive for the pumps is by a steam turbine geared down to suit the speed of the pump. The oil is delivered at a pressure between 20 and 30 psi, to insure that every point is receiving oil. The delivery of oil to every point is free and requires no pressure as the system used is flood and not pressure lubrication.

This flood lubrication is also applied to the bearing springs and to the roller-bearing axle boxes and the pedestal supports.

The sleeve valves, liners, and pistons in the cylinders are lubricated by mechanical lubricators and not by the pumps from the flood-lubrication system, in order to deliver the oil at high enough pressure against the steam pressure. The same oil is used throughout the engine and is a light machine oil with inhibitors called DP.170 manufactured by Messrs. W. B. Dick & Company. The analysis is given in Table 1.

TABLE 1 ANALYSIS OF LUBRICATING OIL

Specific gravity	0.891
Viscosity at 70 deg F	1340
Viscosity at 140 deg F	170
Viscosity at 200 deg F	62.5
Fire point, deg F	475
Setting point, deg F	5
Type PMO	
Closed flash point, deg F	415
Open flash-point, deg F	435

It was thought that this oil would be too light to use under superheat conditions, but results to date have shown quite adequate lubrication with the almost complete absence of carbon. It is yet too early to give convincing proof, but the experimental Atlantic engine originally fitted with a sleeve valve to obtain results ran over 12 months using this oil throughout the test and gave excellent service.

Self-Contained Water Treatment. The engine is equipped with T.I.A. system of water treatment and hand-operated blowdown valves—a recorder registering each time the valve is opened.

All-Welded Boilers. The boiler has no stayed water spaces, so a major cause of repair has been eliminated. The boiler throughout is of welded construction, Fig. 8. No rivets are used except to fasten one stiffening plate in position which carries the longitudinal stays in the firebox back plate. All seatings, which are welded in position, are forgings made of sufficient thickness to replace the usual stiffening plate.

The smoke tubes and flues are welded in position without beading over on the outside of the tube plates, although a certain amount of expanding is carried out on the tubes after insertion into the tube plates.

The firebox heating surface is obtained by the four thermic siphons welded into the roof of the firebox, that is, the underside of the firebox drum. The necks at the lower end are welded into the underside of the boiler barrel. The stays across the flat sides of the thermic siphons are welded in position and not riveted. The boiler is fitted with the standard A-type superheater system.

I would like here to refer to the interest taken in this boiler by Mr. George Russell Carr, and to thank him for his encouragement.

Sleeve-Valve Engine. Each bogie has a three-cylinder double-acting simple-expansion engine driving the three-throw solid-forged middle axle direct. Steam distribution to each cylinder is controlled by a single sleeve valve, this arrangement reducing the clearance volume and increasing the port areas. The cylinders are steam-jacketed.

The sleeve is made of cast iron and fits inside the main cylinder block. This cylinder block is fabricated from steel plate throughout and is welded into the bogie frames, thereby eliminating the use of fitted bolts. Cast-iron liners are fitted on the inside, and the sleeves move inside them. Ports are cut into the liners and also the sleeves to provide the necessary port openings. The main piston oscillates on the inside of the sleeve so that the sleeve provides a kind of movable cylinder barrel. Steam-tightness between the exhaust and live-steam passages and also between live and exhaust steam and atmosphere is maintained by rings much the same as the ordinary piston rings, except that the rings fitted in the cast-iron liners on the outside of the sleeve are internally expanding.

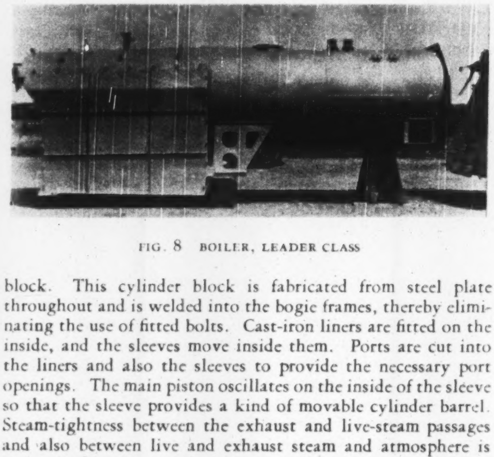

FIG. 8 BOILER, LEADER CLASS

Coupling Axles by Chains Instead of Rods. A major change from normal practice is coupling the axles by Morse silent rocker chains to remove the maintenance and avoid the drawbacks inherent in coupling by rods. The left-hand driving wheel is coupled to the left leading wheel and the right driving to the right trailing. This drive transmits the full turning moment throughout the revolutions of the driving wheels. The system is enclosed and under flood lubrication.

Roller-Bearing Axle Boxes and Circular Pedestals. These engines are fitted with Timken roller-bearing axle boxes working in cylindrical pedestals.

These cylindrical pedestals are attached to the underside of the bogie frames by bolts and fit into chambers in the axle boxes. Between the pedestal and the chamber a sleeve is inserted which is made up of an outer steel sleeve fitted over a rubber sleeve bonded to an inner steel bush. The outer steel sleeve is a push fit in the chamber of the axle box, and the inner steel sleeve is a clearance fit on the suspended pedestal. The thrust from the connecting rod and the coupling chains is, therefore, taken on the rubber, thereby reducing the shock-loading at these points. These pedestals, as already mentioned, are totally enclosed and therefore dust-free.

Other Factors. A factor affecting the utilization of the steam locomotive and also its availability is the need to take coal and water and to get rid of ashes. America once again leads in showing how these operations can be speeded up, operations which can be done at intermediate stopping stations while the train is being dealt with, without taking the engine off the train.

Presteaming plants at depots are in use to allow the engines to be kept under pressure and so be ready for train working without delay, a further factor increasing availability.

Steam-locomotive development has always been handicapped by the absence of proper testing facilities. We have to build the complete locomotive before we can try it and the trials can only be made out on the road.

The first of these new engines has run about 4000 miles. As is to be expected, some troubles have arisen, such as broken ends to the sleeve valves and spalling of the firebrick casing of the firebox, troubles which are being overcome. The engine has shown already the advantage of a double bogie locomotive as regards freedom of running, ease in taking curves, and the great value of having the total weight available for traction and braking.

TABLE 2 PRINCIPAL DIMENSIONS OF LEADER CLASS DOUBLE BOGIE ENGINE

Wheel diam	5 ft 1 in.
No. of cylinders (sleeve valve)	6 (3 per bogie)
Cylinder diam × stroke, in.	$12^1/_4 \times 15$
Boiler pressure, psi	280
Heating surface tubes large and small, sq ft	2127
Firebox heating surface (including syphons), sq ft	260
Total evaporative heating surface, sq ft	2387
Superheater heating surface, sq ft	454
Total combined heating surface, sq ft	2841
Grate area, sq ft	43
Tractive effort at 85 per cent boiler pressure, lb	26300
Water capacity, gal	4000
Coal capacity, lb	8960
Ratios:	
Tractive effort ÷ grate area	612
Firebox heating surface ÷ grate area	6.04
Total evaporative heating surface ÷ grate area	55.5

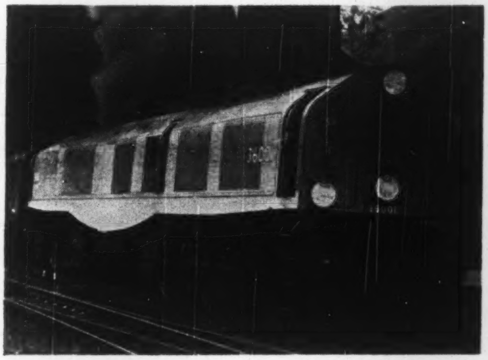

FIG. 9 LEADER CLASS ENGINE IN SERVICE

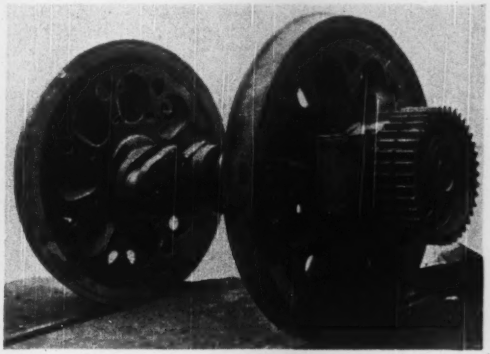

FIG. 10 WHEEL AND AXLE ASSEMBLY, LEADER CLASS

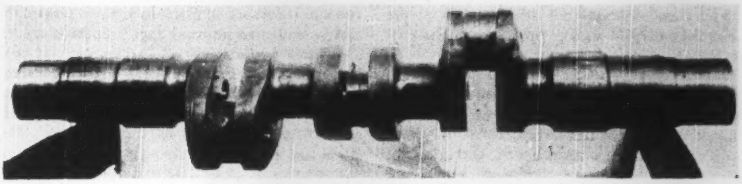

FIG. 11 CRANK AXLE, LEADER CLASS

While in American eyes this is a small engine, its horsepower will be about 1700 and consequently it will give at least as good results as a Diesel-electric locomotive with a 2000-hp engine.

How successful we have been in the new design remains to be seen, but the new features in the engine should give us better service, help to improve the performance of the steam locomotive, and restore steam traction to favor.

Fig. 9 shows the engine on a train at Brighton and shows the exterior of one of the power bogies. The outside casing over the coupling chain from the middle to the trailing axle will be noticed.

Table 2 gives the principal dimensions.

Fig. 10 shows the roller-bearing axle box and coupling, chain and sprocket.

Fig. 11 shows the crank axle.

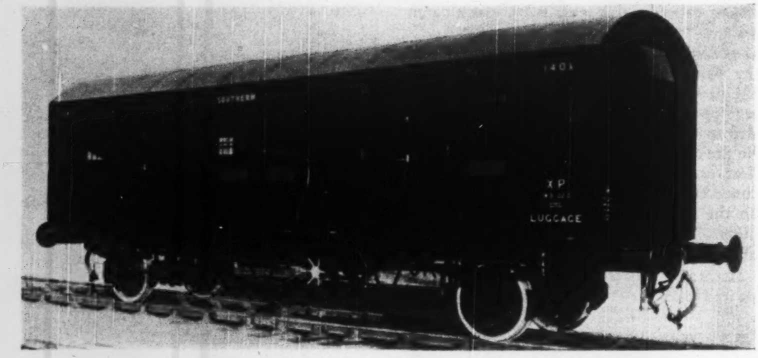

FIG. 12 LUGGAGE VAN WITH REINFORCED PLASTIC SHEETS

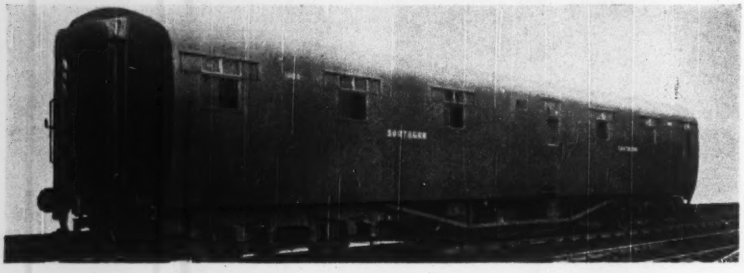

FIG. 13 INSPECTION SALOON WITH PLYWOOD BODY

While in this Leader class of engine the development of the steam locomotive has been carried a stage further, there is still much work to be done.

The use of the blast to create the draft should give way to fans so that we can control the production of steam accurately.

The exhaust steam should not be allowed to escape to the atmosphere, but should be returned to the boiler.

Experimental work already done encourages the thought that these two problems can be solved, and I commend them to the young engineers as worthy of investigation.

I shall feel more than recompensed if I have shown that while the Stephenson locomotive today may in some circumstances be dead or dying, this cannot be said of steam traction itself.

If new designs be developed in the light of our present greater knowledge and the servicing of the locomotive be brought up to date—in short, if only we can demolish the conservatism which is destroying the steam locomotive rather than give up any of its customary ways—then we can look forward to a revival of steam traction.

USE OF NEW MATERIALS AND REDUCTION OF WEIGHT

Reinforced Plastic Sheets. Ten 4-wheel luggage vans were built in 1944 with bodies of light steel framework, employing sections cold-rolled from 12-gage steel strip. The structures were electrically welded, with the exception of the carlines which were made up from ash laminations. The outside panels for the roof sides and ends were of fabric-reinforced plastic material weighing only $11^{1}/_{2}$ oz per sq ft, Fig. 12.

The fabric consists of woven high-tensile steel wire and cotton and is encased in black laminated plastic sheets. The material possesses an unusual degree of physical strength.

Plywood for Car Bodies. The use of steel or aluminum for car bodies has now become world-wide and there is a tendency for other materials having structural merits to be overlooked. An example of a further alternative is to be found in the "inspection saloon" shown in Fig. 13, built in 1946. The body of this vehicle has a shell of $^{9}/_{16}$-in. laminated plywood with suitable pillar sections of similar material resin-bonded to the exterior panels.

Basically the design of the body is that of an inverted ship's hull, the keep plate or ridge rail running down the center of the roof. The sides of the car are bolted to the underframe. The body was built from preformed sections, each section consisting of the length of a compartment and having a width extending from the underframe to the ridge rail to which it is bolted.

Steel Castings in Wagon Construction—20-Ton Cast-Steel Well Wagons. The Southern Railway put into service during 1944, eleven four-wheel 20-ton well wagons. The main members, i.e., solebars, headstocks, transom diagonals, etc., were of cast steel and electrically welded together. The construction of wagons in this manner was unique to Great Britain, and it was necessary to collaborate with the steel manufacturer, The English Steel Corporation, in regard to their production, owing to the length and light character of the castings. The main girders are 32 ft long, are of hollow-box design, and were cast in pairs on a specially leveled concrete floor. The foundry work involved in this matter is illustrated in Fig. 14. The time taken for pouring a pair of castings was 62 sec. The time in the sand was 60 hr. On completion of the casting process it was found that the mold could be demolished in a very few minutes and, with the bottom cores sliding on a smooth floor, contraction took place practically unhindered. The wagons have a clear loading space in the well of 21 ft, a wheelbase of 26 ft 2 in., and a height to the top of the girders from rail for loading of only 1 ft 5 in., as illustrated in Fig. 15. Each wagon has a tare weight of 12 tons 15 cwt, and it is estimated that this is 1 ton less than for a similar wagon if built of rolled-steel sections and riveted together.

The arrangement of springs should be noted. The addition of the coiled spring to the volute spring has been found to give immediate reaction to inequalities in the track and prevents derailment.

Reduction in Weight of Wheel Sets. A reduction in weight is especially important in wheels owing to the kinetic energy stored in the wheel sets at speed, an energy which has to be built up during acceleration and destroyed during retardation.

A consideration of this problem in conjunction with the elimination of dead weight to save steel and cost has led to an investigation into the whole design of wheels and axles which in essentials have remained unaltered since the beginning of railways.

A recent experimental development has great potential advantages when the first practical difficulties are overcome. I refer to fabricated carriage and wagon-wheel sets. The wheel center is formed from a number of pressings welded together into a disk. It is then turned or flame-cut on the periphery and the bore to the desired dimension.

The center is then welded to the axle, then to the tire. The runs of weld metal run lengthwise along the axle and circumferentially round the tire. A light pressure of not more than 10 tons has been used for pressing the center onto the axle to insure the center remaining in its correct position. The completed pair of wheels is shown in Fig. 16.

As the tire is not shrunk on to the center, there are no shrinkage stresses set up in the tire which, consequently, will have a longer life. The careful machining in the bore is not needed. The bore can be rough-turned. The tire being held all round cannot come away if it cracks through.

The stress concentration set up in line with the inner edge of the bore of the wheel center in the axle is also eliminated.

The wheels are substantially lighter, there being neither rim nor boss, and can be manufactured without the usual costly wheel plant. Laterally, wheels of the design in question are much stronger than those with ordinary plain disk centers. A crack has developed in each of three pairs of wheels in the fillet weld metal on the inside of the disk, indicating defective welding technique—slight defects in view of the novelty of this application of arc welding, and most encouraging for the future development of this form of manufacture.

The design may now be said to be a practical one. One consequence of the new design is that the basis of wheel and axle calculations will have to be revised.

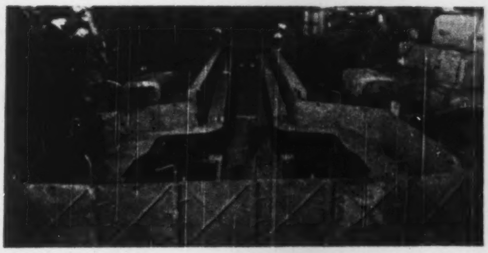

FIG. 14 CASTING MAIN GIRDERS OF A WELL WAGON

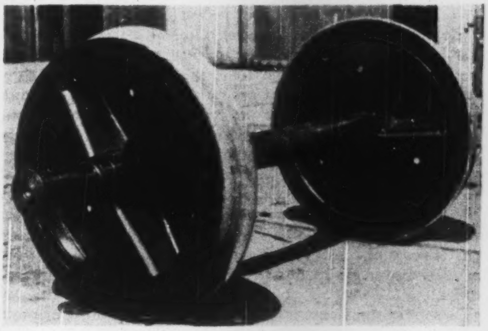

FIG. 16 WELDED WHEEL SET

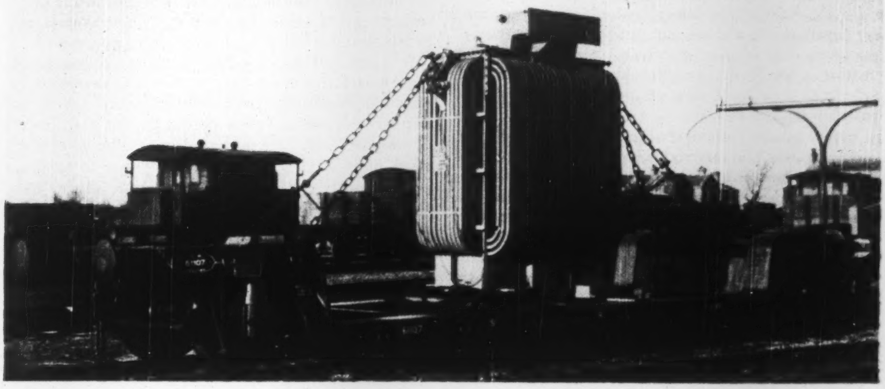

FIG. 15 TWENTY-TON WELL WAGON WITH CAST-STEEL GIRDERS

METALS *for* GAS TURBINES

By NORMAN L. MOCHEL

MANAGER OF METALLURGICAL ENGINEERING, WESTINGHOUSE ELECTRIC CORPORATION, PHILADELPHIA, PA.

THREE and a half years ago, at the Detroit meeting of this Society, the author discussed (1)[1] certain metallurgical considerations of gas turbines. In that discussion he referred to gas turbines for many applications. Some were relatively small and had very short life, as compared with others that would be much larger and necessarily would have to render many more hours of service. He emphasized the very important part that expected life must have in the development, evaluation, and selection of materials for successful application in all types of gas turbines.

In the few years since that time, the greater part of the development and evaluation of gas-turbine materials has been in connection with jet engines and propjet drives for aircraft. Not too much fault can be found with this fact. It was fully expected that the major developments and activity would continue in that field. There was and is the matter of national defense. There was the fact that many engines were to be built, and any manufacturer of gas-turbine alloys and parts had far greater opportunity to sell his product in that field, and possibly recover some of his development costs, than by looking at the very few larger gas turbines that were being built or contemplated.

There was more interest, and that means more money and people available for materials development and study, in the aviation field. The interests of the Navy Bureau of Aeronautics, the Army Air Forces, the National Advisory Committee for Aeronautics, the four principal jet-engine builders, and the several aircraft manufacturers, would assure activity. The work of the Society of Automotive Engineers in creating "AMS" specifications for high-temperature materials for aviation gas turbines has been an important contribution. Through its Subcommittee on Heat-Resisting Materials, the NACA provided the best clearinghouse for data and studies on all phases of gas-turbine materials development. The formation of an active Aviation Panel in the ASME-ASTM Joint Committee on the Effect of Temperature on the Properties of Metals provides a further center for concerted planning and evaluation.

It is worthy of comment that there has been excellent cooperation on the part of so many individuals, companies, government departments, and research groups, in the advancement of our knowledge of these materials. Most have looked upon the matter as one of national effort and advancement, and have freely offered their data, their personnel, and their facilities to a common improvement.

One can hardly escape the impression that the greater part of the facilities, minds, and materials of our alloy-development sources, the greater part of our testing facilities and personnel, and most of our best evaluating minds, have largely been employed through these years in developing materials for comparatively short-life apparatus, jet engines, propjets, ramjets, rockets, and the like.

Many of those interested in gas-turbines for other purposes than aviation have had to depend very greatly on the aviation developments. While it may be carrying things too far to liken them to Lazarus eking out a living from the crumbs that fell from the rich man's table, nevertheless there has existed too much of a feeling at times that all of the needs could be derived from the aviation developments.

It is the real purpose of this discussion, then, to try to stimulate more thought and activity in metallurgical development of gas-turbine applications in other fields than aviation, such as for transportation both in ships and locomotives, for oil and gas-pumping service, and for stationary primary power purposes.

Such applications immediately suggest problems and the need for information that can hardly be supplied by the aviation studies. Long expected life running into years, the corrosive effect of cheaper and poorer fuels over those longer periods of time, and the resulting effect on the rupture and fatigue properties of the materials as a time matter, the need for larger pieces of material than heretofore produced, and the question as to how well the properties developed in small pieces can be realized in larger pieces—these are but a few of the problems before us.

The question of thermal shock has been considered by many. But studies and conclusions arrived at in sizes and designs that live but a few hundred hours may not be applicable at all to larger sizes and varying structures that must last years, if they are to earn their right to existence.

There has not been the same opportunity for material developers and evaluators, if I may use such terms, to get together and compare notes, and benefit from each other's experiences, as has existed in the aviation activities. This is understandable. In general, there has not been the same recognition of any national defense, nor of an over-all national effort, such as appears to exist to some degree at some places abroad, in all phases of gas-turbine development.

Possibly the creation of the Gas Turbine Power Panel of the ASME-ASTM Joint Committee on the Effect of Temperature on the Properties of Metals may offer the place for an ethical, yet fairly free, discussion of the problems before us. Already, research plans are being studied. These studies will sooner or later require financing, if they are to go forward.

It is believed that a critical look at our present position as regards metals for long-life gas turbines has some merit. There are some interesting risks involved when anyone attempts a critical evaluation of the supposed present position in a rapidly developing field. He may readily be accused of not knowing what he is talking about. It is obvious to anyone who has been seriously engaged in gas-turbine metallurgy that few persons, if there be any, really know of all the investigations that are under way. Much information is still classified as secret, confidential, or restricted. One just does not talk about many matters. No doubt some alloy-development groups and some engine builders have developments under way, or nearing completion, that they prefer to keep to themselves for a while. Perhaps the very metals that we need, or the data that we need so badly, are there, right around the corner, and we do not know it. It could be, but we have no reason to believe that it is so.

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[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

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A critical review or outlook should not be too critical; it must by all means be constructive.

Quite often the author has heard a complaint voiced by a number of those actively engaged in the development and evaluation of these high-temperature materials that if they knew better what was wanted, what the designers were thinking of, what the designer really wants as regards test data, perhaps they could make their contribution more intelligently and thus more effectively, than they may appear to do at present. Society meetings offer a forum for this purpose.

SURVEY OF LONG-LIFE GAS TURBINES

Recently there appeared in the technical press a survey (2) of all the long-life gas turbines in operation, built or building, or under design. This survey is an excellent one for study by those engaged in material development. If one overlooks the "experimental and shop units" for the time, there are listed some 27 stationary units, 10 locomotive units, and 6 marine units. No doubt there are additional items that have been added since the survey was made, and it will be appreciated that there are some few others of a secret or confidential status that were not listed.

The United States part, 7 of the stationary units, 6 of the locomotive units, and 3 of the marine units should be noted. More important, it will be observed that the United States designers are aiming at higher inlet temperatures, in general, than those abroad. In the stationary field, it is 1350–1400–1500 F in the United States; 1200–1250 F in England; 1000–1250 F in Switzerland; and 865–1300 F in France. Eleven units ranging from 1200 to 27,000 kw at inlet temperatures of 1000–1100 F, on the part of one Swiss concern, cannot escape the notice of metallurgists interested in this subject. The pattern as regards temperatures is well set forth. The general characteristics of these gas turbines have been listed in considerable detail, and are worthy of study by metallurgists and others engaged in materials evaluation. Relative size, inlet temperature, speeds, general construction, whether cooling is employed—these are matters for the metallurgist to observe and consider.

GENERAL MATERIALS CONSIDERATIONS

In considering materials for gas turbines, it may be helpful to group the necessary materials into two general classes:

1 The high-temperature metals necessary for a comparatively few "hot" parts, such as the combustion liners, the hot casings and ducts, high-temperature bolts, the rotor of the gas turbine, and the turbine blades or buckets.

2 All those other materials for compressors, gears, auxiliaries, heat exchangers, etc., that probably are available in sufficient development for our present needs.

For the immediate purpose, it is believed the second class may be disposed of rather briefly.

The need for bigger and better aluminum-alloy forgings has been mentioned before. Some improvements have been made. But the desire for aluminum alloys for higher temperature service than available before appears to have faded as there came the realization that aluminum alloys were probably never meant for those higher temperatures. Improved ductility is definitely desirable.

Instead there has been a surging interest in titanium and titanium alloys, and there is every reason to believe that these materials, despite their high cost, will find prompt application in jet engines and the like. High cost and low production will probably prevent their use in other gas turbines for the present.

Interesting and complex corrosion problems have arisen in connection with various heat exchangers for gas turbines. A wide variety of materials in the necessary shapes, such as tubes, sheet and plate, are available, and should readily meet the conditions, as they become better understood. The use of salt-laden air may also introduce problems of corrosion into the compressor, and other parts, during shut-down conditions. This, however, is no new problem, and there are ways of taking care of it.

Let us turn, then, to the hot parts of the gas turbine, and see what progress we have made with them.

COMBUSTION LINERS

In 1946 the author pointed out (1) his belief that, in general, reasonable service life for combustion-chamber liners would be accomplished more through careful and ingenious design than merely by seeking more and more resistant materials. This has been confirmed. Inconel and 25/20 chromium-nickel steel are still largely favored for the purpose. Examination of these materials after 1000 hr of life shows negligible attack, and no reason for not expecting long and undisturbed service. Indeed, liners made of several superalloys did not behave so well.

TURBINE CASINGS AND DUCTS

One naturally thinks of castings, forgings, and welded construction for these parts, depending on sizes, shapes, pressures, and the other features present. It is believed that difficulties of procurement and manufacture are far more important at this stage than the material itself. Existing materials appear adequate. Difficulties have been encountered by some builders in getting good sand castings. Some attempts have been most discouraging.

Actually, forgings have been used by some builders. While high in first cost, they are often much more economical in the end than castings. The pattern cost is avoided, and much time and expense of repairing steel or alloy castings is eliminated. Also, heavy plate sections are difficult to procure, in the limited quantities wanted, and forgings again must be employed for these needs.

On the other hand, quite excellent centrifugal castings have been made available in a wide range of sizes for aircraft-engine applications, and offer much for long-life turbines as well.

Real progress has been made in building up casing members by welding together forged parts, some cast parts, especially centrifugal castings, plate and sheet.

HIGH-TEMPERATURE BOLTING

One has a choice of a number of bolting materials that have already been used to some degree in service, although for short periods of time. Steam-turbine practice has employed the alloys EME and N-155 at actual temperatures of 1050 F for over a year. The nickel-base alloys, such as K-42-B and Inconel-X, have been used for various time periods at 1000 F to 1200 F, and even higher. The alloys N-155, S-590, and S-816 have been used to some degree, at higher temperatures. One observes a growing demand for more and better data on these and other bolting possibilities, as to their relaxation behavior over long periods of time; how susceptible are they to cracking at the root of the threads, or under the heads; how tightly should they be pulled up; how brittle do they become after long service exposure; how many times may they be retightened?

TURBINE ROTORS

In the author's opinion, the rotor of the long-time gas turbine presents the most important metallurgical consideration of the moment.

In the case of jet engines, most of them employ a single disk rotor, and some of them, especially the larger ones, have two separate disks secured together by bolting. There has not been much change in the disk alloy since the first engines. Timken alloy and the 19-9-DL alloy steel are still largely employed for the purpose. The composite disk made up of a ferritic steel center with a rim of Timken alloy welded to it has been successfully employed in several engines, and this approach is growing in over-all interest. The British G-18-B alloy has found its way into American practice, but its continued use is somewhat questionable. The Discaloy alloy is now in the process of adoption and use on a broad scale, in order to meet the demands for a better material. Greater advances have been made in improving the quality of the existing alloys in disk form than in making new ones. Greater strength, greater ductility, improved soundness, improved over-all reliability of the existing alloys have been realized. The Kellogg process (3) for the production of improved ingots for disk manufacture is growing in favor. Contour forging of the disks in specially developed dies has increased reliability. Disk failures are a thing of the past.

In the jet-engine field, one hears the oft-repeated, half-joking, half-serious, remark "over alloyed," as regards disks in our current engines. There is much serious thought being given to a reduction in the amount of critical materials that are used in disks. Some ferritic materials are being seriously considered. An extension of the use of the composite disk is under consideration.

As to larger and long-life gas turbines, the following statement is quoted from the 1946 discussion (1):

"For high-temperature steam turbines, for long service, we have learned that the single-piece rotor forging is best. Thought naturally moves in that direction for gas turbines where even higher temperatures are involved. However, it would appear that our knowledge and ability to handle larger masses of these heat-resisting alloys has not reached the stage where large reliable forgings are possible, and we must rely for a while on disks and assemble them together by welding or other means to meet our development needs. Indeed, it may not be surprising that the disk construction or the composite construction will be the final word in the matter."

A number of articles (4, 5, 6, 7, 8, 9, 10, 11, 12) in the technical press and before this Society have included illustrations and comments relative to rotor construction, as employed by the four American manufacturers. It is of interest and it is quite important from the standpoint of over-all experience and development that they have seen fit to approach the rotor problem in different ways.

One builder has seen fit to endeavor to procure single-piece rotor forgings for a number of designs. It must be recalled that in steam-turbine practice, as temperatures were increased to present levels, the one-piece rotor has become almost the rule for central station and marine applications, replacing the older built-up designs. Was it not natural, with gas-turbine temperatures even higher, to follow the same approach, rather than go back to the troublesome built-up designs?

The probable difficulties of procuring single-piece rotor forgings were fully appreciated, and they have been experienced. Losses have been high, delays have been great. There have been only a few courageous persons willing to try them, again and again. Some sound acceptable forgings have been produced in the simplest of alloys, 19-9-DL. In the more highly alloyed materials, one company appears to be convinced that the future will have need of this form of construction, and is willing to put its abilities to work on the problem.

Abroad, it is observed that a British steel plant produced a number of one-piece rotor forgings for one of the Swiss builders. Diameters of 20-in., 25-in., and 30-in. were noted. But reports are conflicting, one that they were excellent sound forgings, another that they were found to be quite unsound and could not be used.

Two of the American four companies have built up multistage rotors by welding disks and stub shafts together. One of these employed rather shallow welds at first, fashioned somewhat after an older European practice on steam-turbine rotor construction. Cracking of these welds was experienced. There has followed a long period of welding development, and latest reports are that the difficulties have at last been overcome. Gas-turbine operating experience has been seriously delayed through this experience. The story of the successful solution to this problem will be of interest to all.

The other of these two builders employed a somewhat deeper welding groove, similar to that which he had so successfully employed in steam-turbine practice years before. It has been reported that while these practices were quite successful with one high-temperature alloy, cracking was experienced with another of the more highly alloyed types.

The fourth builder has used a welding approach, but of different nature. He has borrowed the composite wheel from its very successful performance in jet-engine and propjet units. The construction is covered in U. S. Patent 2,432,315. The hub or center is made of a ferritic nickel-chromium-molybdenum-vanadium steel, to which is welded a rim forging of the Timken alloy, or other suitable heat-resisting steel. Blade or bucket seating is in the rim portion. The ferritic steel center must of course be cooled to keep its temperature below 1000 F, the lower the better presumably. So far as is known to the author, these disks have not been used in more than two-stage turbines, and they have been bolted or welded together. The welding in this case is between ferritic steel. In the welding of the rim to the ferritic steel center, no particular trouble has been reported, and none would be anticipated. It is generally experienced that welds between ferritic and austenitic members give little or no trouble in welding. Off-hand, there appears to be no good reason why multistage rotors of any reasonable number of stages could not be constructed in this manner, but the problem of cooling all of the disks would no doubt introduce some problems.

There are many arguments in favor of the composite wheel approach. Since the ferritic steel of the center is low-alloy steel, the same type of steel regularly used for steam-turbine rotor forgings, it is well established from the standpoint of ready manufacture in almost any size desired. It is low in alloy content, and would not present a critical material problem in time of emergency. It has the background of many years of successful service for high-speed, high-temperature rotating bodies. It will no doubt be superior to any of the high-temperature alloys from the standpoint of thermal shock.

On the other side, we must await the experience of time as to what metallurgical changes or deterioration may take place in the metal adjacent to the weld. We have seen and heard of objectionable carbide segregations adjacent to the weld, and lowered ductility as well. But even these may have little or no effect on the usefulness of the parts.

There is another approach, that is, the mechanical fastening together of disks to form the desired multistage rotor. We know from our jet-engine experiences that metallurgical knowledge can now produce excellent disks up to 30 in. or so in diameter. If there are but two or three disks, there are various methods of bolting them together. Or if there are many disks, the central bolt method (U. S. Patents 2,458,148 and 2,458,149) may be useful. In either case, disks may be doweled together, or each disk may have projecting flanges having face splines engaging with similar splines on the adjoining disk. It remains to be seen, however, if such mechanically jointed disk construction can remain useful for long times of high-temperature operation.

While discussing the rotor situation, it is well for us to remember that, as a rule, the high-temperature alloys are possessed of low thermal conductivity, and high expansion characteristics and they are probably notch sensitive, making it very necessary to consider the importance of ductility at high temperatures, and to avoid such high stress concentration as would occur at notches, sharp corners, etc.

BLADING OR BUCKETS

There are, in general, three methods of producing turbine blades for gas turbines:

(*a*) By machining from rolled and heat-treated bars or special shapes.
(*b*) By drop-forging and machining as required.
(*c*) By precision-casting methods.

Method (*a*) offers the simplest metallurgical control, it is the cheapest method, and the most reliable production method. Operators can be readily trained to perform standardized operations. The method is wasteful of critical materials. In its simplest form, it may result in compromising a desired shape of the blade. Some of the better materials do not machine any too readily.

Method (*b*) offers reasonable freedom to the designer as to shape. Costs are apt to be high by reason of die upkeep and life. Depending on the shape, waste may be high. As pointed out before (1), materials that forge readily are not apt to be good materials for high-temperature service. Better materials from the service-temperature standpoint may be difficult to forge, if not impossible.

Forging practices differ. Some endeavor to practically finish forge the port of the blade to size, and machine only the root portion. Others do not try to forge to size, but employ the forging operation to improve the structure, to conserve metal (over the 100 per cent machining method), but they still do machine all over. Any attempt to finish forge thin trailing edges too close to size may result in damage to that edge.

Precision-casting methods offer a means of avoiding many of the foregoing objectionable features. One can cast that which cannot be forged or machined. One can readily appreciate that temperatures may be reached where only cast materials may be used.

The casting method should be the most economical approach. But with production yields of but 35 per cent to 65 per cent of the blades cast, there is much room for improvement along these lines.

Cast blades are characterized by wide variations in grain size, and by rather wide variations in high-temperature physical properties. Better metallurgical control is in the making, but results in actual practice are slow in being realized. We do not as yet know how serious is this matter of grain-size variation.

Such extreme statements have been made by some that they would prefer the poorest blade forging possible, in preference to the best precision-cast blade possible. In the aviation field, we must recognize that the operating experiences with cast blades are much more extensive than with forged or machined blades, and one can hardly place cast blades in second position.

Of course, proper design and metallurgical control must be used for either, in a degree necessary to the design and material and process being employed. It is feared that poor cast blades, or poorly designed cast blades, have often been used to compare with the best forged blades.

The question of cast versus forged gas-turbine blades for long-life turbines will not be settled in the immediate future. It is believed that the long-time feature alone will settle the issue, and decree which is best. And since the casting method will steadily improve in the meantime, a really conclusive decision may take even a longer time.

The question of shrouding of rotating blades in long-life gas turbines has been met in some designs. Induction heating of the tangs followed by hand or machine riveting, has been successfully carried out by at least two of the builders. To maintain desired properties in the tangs after such operation is an important consideration.

Corrosion and fouling of gas-turbine blades in long-life turbines are much before us. The time factor is so great as compared with operating experiences in the jet-engine field, and there has been so little real operating experience as yet with the larger gas turbines in this country, excepting under closely controlled laboratory conditions, that we must await experience itself. Lower-grade fuels than those used in aviation, may introduce corrosion problems entirely different than the minor corrosion so far experienced.

Hollow blades, it is believed, merit our more serious consideration. They would help in saving critical material. They would permit of cooling. They would result in lower stresses on the blade fastenings. This last may be more important as temperatures go up.

ALLOY DEVELOPMENT

The accelerated research of the war years, and the years immediately following, developed a host of new alloys for jet engines, rockets, etc. It must be recognized that few of these alloys have found their way into actual application in engines. To many metallurgists, this has been most discouraging, especially when so many engines were to be built. The long-life units so far built have largely used the same materials as the jet engines, and there has been no opportunity to try out the various other materials there.

We have rather complete short-time data from the laboratory on many of the alloys; on others our data are rather sketchy.

In the long-life gas turbines, although we use certain of the materials, we do not know enough about them to predict what they will be like after years of service. The setting up of test programs on the alloys now being used, and the more promising of those not yet applied, be they old or new, so that test data may be accumulated and studied, would appear to be a matter of first importance.

In high-temperature alloy development, first impressions of the problem are often apt to send us too far afield. It is a healthy note that some jet-engine builders are stopping and looking back now, to see if there may not be less-rich alloys or ferritic steels that may be employed for some parts, that may be used in-between our older fields of materials and the 1200 F field of our newer alloys.

So far as the 1200/1500 F level is concerned, it would appear that the various alloy fields have been fairly well explored. Improvements in this temperature range are more apt to be made by studying the structure, the influence of heat-treatment and of hot- and cold-working, such as proposed by Franks (13) and Freeman and his coworkers (14), than by further alloy variations and additions. When one considers that Freeman found it possible to vary the time for rupture under 40,000 psi from 100 hr to an estimated 600,000 hr for the same N-155 bar stock with different treatments, the importance of our knowing our present alloys better is apparent. When one considers the spread in physical properties that can be secured in a single master heat of alloy for precision-cast blades, again it should be realized that we have much room for improvement in what we already have.

Much time and effort and money have been expended to develop alloys that might have worthwhile load-carrying ability at higher temperature, such as 1600/1750 F. Many alloy fields have been explored. Iron, nickel, cobalt-base alloys, with roughly up to 20 per cent or more of chromium, and with additions up to 7 per cent of molybdenum, to 6 per cent of tungsten, to 4 per cent of columbium have been tried. All sorts of combinations of iron, nickel, chromium, cobalt, tungsten, molybdenum and titanium have been covered. Some few rays of hope still exist. But there appears to be a growing conviction that we are just about through. Of course the following are still to be fully explored: Chromium-base alloys; titanium-base alloys; molybdenum-base alloys; and tungsten-base alloys.

One of the war-time investigations developed a chromium-base alloy. This alloy has been worked on very diligently by one of our best alloy-development groups, constantly since the close of the war. It has excellent properties, but as yet its manufacture into useful articles has not been realized. The excellent properties have been verified by a third laboratory, and attempts to vacuum-cast blades of it are still ahead.

There are some who feel that titanium in fairly large amounts may yet have great value in high-temperature alloys. Others do not share this view. Further work will clarify this issue in the near future.

Molybdenum and molybdenum-base alloys will receive much attention in the immediate future. But successful application will require the perfection of some means for coating the parts with an impervious protecting surface, to avoid oxidation of the molybdenum.

It is worthy of note that at least three independent development groups have under improvement at the present time, alloys containing increasing amounts of tungsten, and there is some feeling that these may be superior to any of our existing 1500 F alloys.

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Locomotives *and* Smoke *in* Pittsburgh

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IT is my experience that an expert locomotive fireman can fire a locomotive in general service without making smoke. This applies to the present-day locomotive with or without a stoker and without the help of steam jets.

This being so, the locomotive smoke problem is a matter of training firemen. The real difficulty lies in controlling the unruly human element. Unfortunately, we cannot train all firemen equally well, in spite of the time and care put on them, simply because of the psychology of mankind generally.

Although it may be possible to train any locomotive fireman to keep the smoke within the ordinance restrictions, can we make the steam locomotive nearly enough foolproof so that a man with little or no training is a satisfactory fireman?

My experience is that we cannot. Take steam jets, or, more correctly, steam-air jets, for instance. Just as long as a valve has to be turned or a lever manipulated, there will be man failures. Some men are indifferent, some are lazy; and even with the best intentions there will be errors or mistakes. I do not see that it makes any difference whether the steam jet is automatic or not; a fireman's reponsibility cannot be entirely eliminated. The very fact that he is a fireman indicates that the fire is his responsibility.

I have always questioned how much steam jets really help the fireman. I know that certain cities require locomotives to be equipped with them and we all know that steam jets will stop smoke if they are properly used, but there are other ways of introducing air over a fire.

In Pittsburgh we have a number of railroad inspectors. They are men of long experience, first as firemen and later as engineers. These men are experts. I overheard one of them say the other day: "The locomotive was smoking badly and the first thing I did, as soon as I could get in the cab, was to open the fire door and admit air so that the locomotive could clear itself of smoke."

Everyone of these men have told me again and again that they can fire any locomotive without making smoke by merely manipulating the fire-door opening.

We made a test on April 11, 1945, on the tracks just outside of the Pennsylvania Station in Pittsburgh, in the presence of a number of railroad officials and others. We had a Pennsylvania Railroad switching locomotive of Class H 10 without steam-air jets. A standing test showed that by cracking the fire door a No. 5 smoke was brought to a No. 1 light haze in 4 sec. In running tests the same result was obtained in 3 or 4 sec.

I am not opposed to steam jets nor am I trying to discredit them. If anyone says he cannot get results without them, he should by all means use them. In Pittsburgh, however, we have no steam jets. There are none on the Pennsylvania Railroad and the two or three on other roads I understand are not used. Yet the results we have gotten in Pittsburgh have been amazingly good.

We had 13 railroad smoke inspectors in 1948 in Pittsburgh.

(*Continued on page 481*)

Based on a brief address at the Railway Club of Pittsburgh, Pittsburgh, Pa., Feb. 23, 1950.

Tests on DYNAMIC RESPONSE *of* CAM-FOLLOWER SYSTEMS

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INTRODUCTION

A CONTROVERSY has existed for some time over which of three commonly used cam profiles would provide the most desirable follower motion in cases where that motion is not prescribed by the requirements of the machine of which the cam is a part. The three profiles in question are curves of parabolic, harmonic, and cycloidal form. A desirable follower motion is one which requires minimum time, provides smooth acceleration and deceleration of parts, and provides positive accurately controlled motion. This motion should be produced by a cam which is inexpensive to make and which requires a minimum of maintenance.

The controversy has been concerned with the accelerations and related forces produced in a cam-and-follower system by each of the profiles in question. In the past, one school of thought held that accelerations should be kept to a minimum at all times, in order to keep forces low, and, since the parabolic profile provides the lowest over-all theoretical acceleration value of the three, it has become a very popular profile. The theoretical peak acceleration for the parabolic profile is only 81 per cent of that for the harmonic and 64 per cent of that for the cycloidal profile. These facts have been a powerful argument in favor of the parabolic curve, but that argument neglects completely any effects which might be introduced into a cam-and-follower system by the rate at which acceleration and corresponding force are applied to that system. This argument has been carried on in spite of the fact that with constant acceleration and deceleration characteristics, the loads must be applied and removed instantaneously. It follows that the resulting peak forces must be influenced by the sudden application, reversal, or removal of operating forces.

The harmonic profile has an advantage, in that its maximum pressure angle is smaller than that of either of the other profiles. The cycloidal contour has no such obvious advantages. It has a sinusoidal acceleration curve which, up until fairly recently, has received only a small amount of attention. The literature on the subject of cam profiles has confined itself almost exclusively to the advantages of the parabolic or harmonic type of profile, and only recently have investigators made further analyses, based upon the effects of rate of application of acceleration, and system elasticity, a factor which had always been neglected.[1]

DESCRIPTION OF APPARATUS AND TESTS

Tests were made with parabolic, harmonic, and cycloidal cams under identical test conditions. The cams were of the internal-groove plate type, made of cast iron, and were run with hardened steel rollers $1^1/_8$ in. diam. The finished cams were measured so that profile and track-width variations would be known. The tolerances achieved averaged less than ±0.001 in., with maximum values of ±0.0015 in. All three cams had a 2-in. rise, 70-deg angle of rise, and 70-deg angle of fall, with two 110-deg dwell portions. They were so calculated that the harmonic cam would have a maximum pressure angle of 30 deg. Maximum center-line radius in all cases was 6.657 in. The cams were run with both a swinging and a sliding follower system. Provision was made for changing the moment of inertia and natural frequency of the follower systems by moving a weight between a series of fixed positions on the swinging follower arm or on the vertical accelerometer beam of the sliding follower. Forces exerted on the follower were measured by means of electrical strain gages, the output from which was fed into a Brush strain analyzer and recording oscillograph.

Fig. 1 shows the testing machine as operated for the tests made with the sliding follower. In the illustration the cam can be seen at center directly below the driving belt. The shaft carrying the cam is mounted in tapered roller bearings and carries a heavy flywheel. The vertical accelerometer beam and velocity-measuring device can be seen at the left. The slide is carefully fitted and moves on the cam center line, the follower roller moving in a track on the under side of the cam.

Strain gages on the accelerometer beam were used to measure the force on the follower which was proportional to its acceleration, while the velocity of the follower was measured by a simple linear generator mounted on the follower. Plots of both acceleration and velocity were made directly with the recording oscillograph. The acceleration values were calibrated directly in force units, but no velocity calibration was made. Only relative values of both velocity and acceleration were considered.

Tests were made on all three cams at fixed speeds from 20 to 170 rpm, and with follower natural frequencies of 20 to 162.5 cycles per sec (cps). In addition to these tests, two others were made as follows:

1 With swinging follower natural frequency of 50.3 cps, the speed was varied from the maximum at which the cams could be operated down to zero. Continuous force-time plots were made, and the speeds at which the follower system came into resonance were noted.

2 With sliding follower natural frequency of 36.5 cps, the speed was varied as before. Continuous force-time and velocity-time plots were made, and resonance points were noted.

During all the tests, special attention was paid to the dynamic operation of the cams as compared to the operation predicted in the calculations.

RESULTS AND DISCUSSION

The time-displacement equations for the three cam curves considered are as follows:

Parabolic

$$\frac{X_f}{L} = 2\left(\frac{\theta}{\theta_0}\right)^2$$

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[1] "An Analysis of the Dynamic Forces in a Cam-Driven System," by J. A. Hrones, Trans. ASME, vol. 70, 1948, pp. 473–479.

Contributed by the Machine Design Division and presented at the Spring Meeting, Washington, D. C., April 12–14, 1950, of The American Society of Mechanical Engineers.

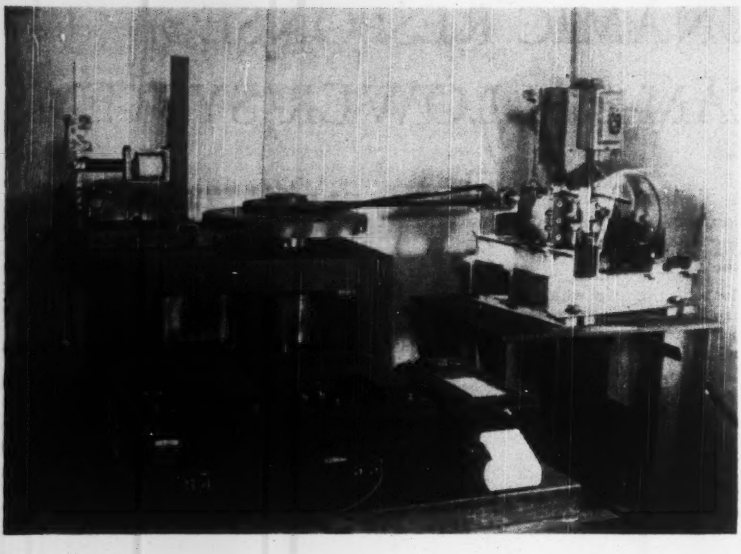

FIG. 1 TESTING MACHINE WITH STRAIN-RECORDING EQUIPMENT

Harmonic

$$\frac{X_f}{L} = \frac{1}{2}\left(1 - \cos\frac{\pi\theta}{\theta_0}\right)$$

Cycloidal

$$\frac{X_f}{L} = \frac{1}{\pi}\left(\frac{\pi\theta}{\theta_0} - \frac{1}{2}\sin\frac{2\pi\theta}{\theta_0}\right)$$

where X_f = displacement of cam follower
L = total cam rise
θ = angular displacement of cam
θ_0 = angular displacement of cam required to produce full follower rise

The displacement-time curves plotted from the foregoing equations are shown in Fig. 2, while the acceleration-time curves plotted from the same equations are shown in Fig. 3. These curves do not take into account such factors as the follower-system elasticity, or the static or viscous friction which appears in any actual machine system. When these factors are taken into account, as they must be in any actual tests, an entirely different force picture appears. Typical acceleration-time charts made from the tests are shown in Fig. 4. The accelerations are directly proportional to the forces being exerted on the follower in each case.

The charts in Fig. 4 show two important characteristics which are not apparent from the theoretical curves in Fig. 3. They are (1) that the forces produced by the parabolic and harmonic profiles are about twice as great as expected; and (2) the sudden application of these forces causes the follower system to vibrate at its natural frequency. The vibration takes place during both index and dwell periods.

It can be shown mathematically that the deflections of an elastic and undamped system produced by instantaneously applied forces are exactly twice as great as those produced by gradually applied forces. It follows, therefore, that the stresses produced must be twice as great. In the systems considered here, the inherent elasticity and slight damping produced the force amplification which was noted. Analyses of cam profiles and the forces produced by them have generally neglected this very important fact, but it is readily apparent from the tests made that if a complete dynamic analysis of the performance of a cam is to be made, the follower-system elasticity and the damping appearing anywhere in the assembly must be considered. It must be remembered also that the motions studied occur between two dwell periods.

The theoretical acceleration curves for the parabolic and harmonic cams show clearly how the follower-system vibration is excited. The vibration is caused by the sudden force application which is a characteristic of the two profiles. Any system, acted upon by an instantaneously applied force, will vibrate at its natural frequency until and unless the vibrations are damped out. Furthermore, as the frequency of application

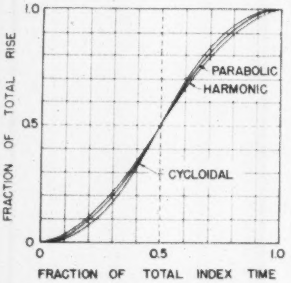

FIG. 2 FOLLOWER DISPLACEMENT VERSUS TIME

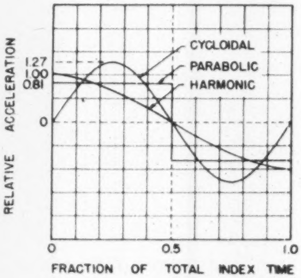

FIG. 3 FOLLOWER ACCELERATION VERSUS TIME

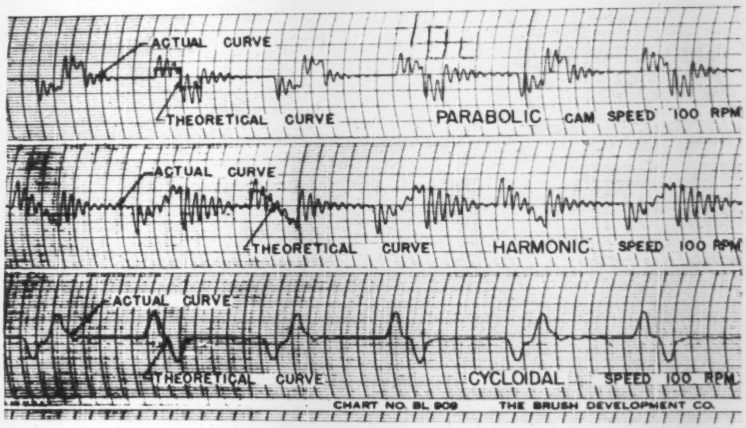

FIG. 4 TYPICAL ACCELERATION VERSUS TIME CURVES

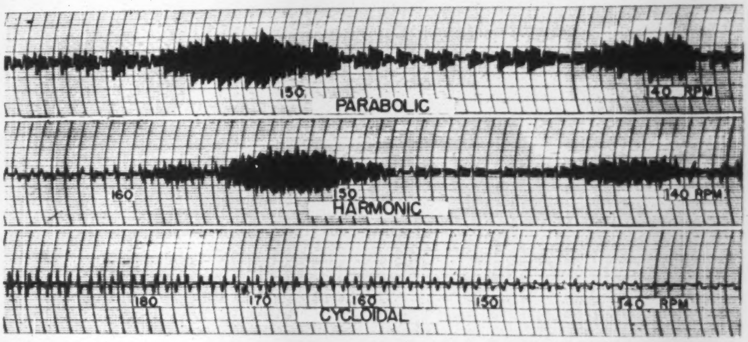

FIG. 5 FOLLOWER RESONANCE CURVES

of the impressed force approaches odd integral multiples of the natural frequency of the system in question, that system starts to resonate, and the amplitude of the vibrations increases drastically. The impressed force which causes the vibration may be one which is applied instantaneously with a definite frequency of repetition, or it may be one which varies sinusoidally with time. All that is necessary to produce resonance is that the frequency of the impressed force be in the proper ratio to the natural frequency, and that the two have the proper phase relationship.

The conditions just discussed were all noted in the tests which were made on the parabolic and harmonic cams. They appeared to only a very small degree in the cycloidal profile tests, because there is no point on the cycloidal displacement curve at which instantaneously applied accelerations occur. The acceleration changes continuously, but its rate of application is always definite and relatively small.

The conditions mentioned are illustrated in Figs. 4 and 5. Fig. 4 shows the effect of the instantaneously applied acceleration. A considerable amount of vibration is excited here and dies out in accordance with the amount of damping which is present. It is interesting to note that in the case of the parabolic and harmonic cams, a large amount of follower vibration takes place during the dwell period. This situation appears to a much smaller degree with the cycloidal cam.

Fig. 5 shows the effects of resonance on the stresses appearing in the follower system, and forces produced by the follower system. In the curves, the speed of rotation was reduced gradually and the follower system allowed to resonate at will. The parabolic and harmonic profiles both excited resonance at speeds of about 150 and 140 rpm, while the cycloidal profile showed a slight tendency to excite resonance at about 160 rpm, and again at 190 rpm, a speed which could not be attained with the other cams because of excessive machine vibration. It must be remembered, of course, that a change in cam-follower natural frequency will change the speeds at which resonance takes place. In all the curves in Fig. 5 the follower natural frequency was 162.5 cps.

In the tests made, the damping in the follower system was about 5 per cent of critical. This value is low for most common cam-and-follower assemblies, in which the damping may be as much as 15 per cent of critical. If an increase is made in the damping, the damping forces will increase very rapidly, since they are proportional to velocity. At high speeds and high damping ratio, the damping forces may be expected to be much larger than the inertia forces, and the increase in damping will

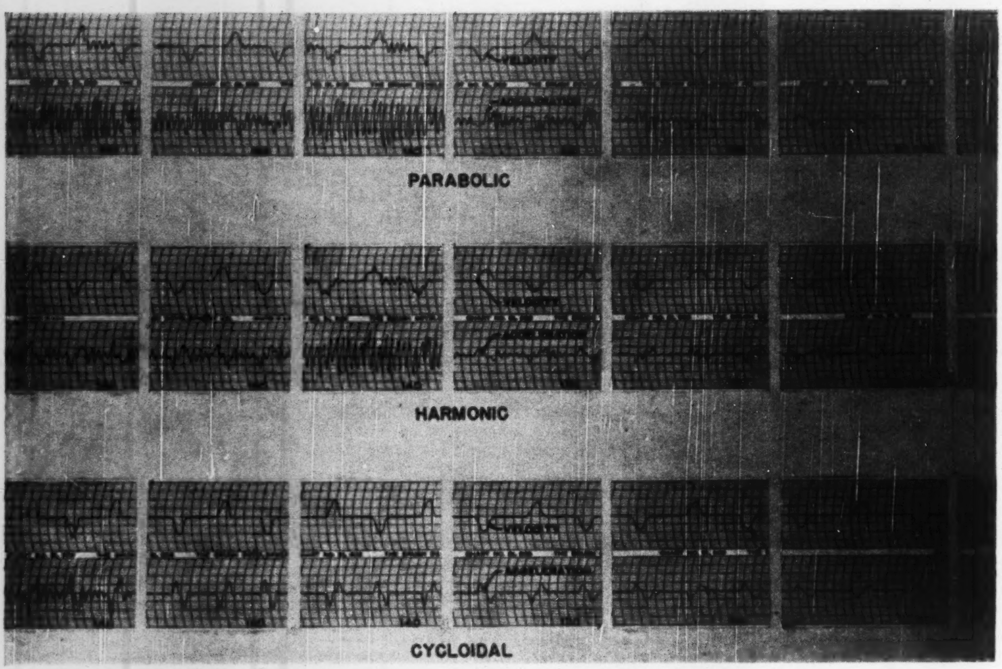

FIG. 6(*a*) FOLLOWER VELOCITY AND ACCELERATION VERSUS TIME AT FIXED SPEEDS

have no net beneficial effect. In fact, the excessively high damping forces may be a disadvantage which necessitates the redesign of some machine parts.

Figs. 6(*a*) and 6(*b*) form a continuous chart of velocity, and acceleration or force against time for the three profiles studied, at speeds varying from 160 rpm down to 60 rpm. During this test the only variable was the cam rotational speed, all other factors being held constant. The charts show that in general the cycloidal profile does not cause excitation of follower resonance, as do the other profiles. The cycloidal profile allows the follower to reach a dwell position without the excessive vibration caused by the other profiles. It should be noted also that the peak velocity values do not decrease with decreasing cam speed nearly as rapidly as do the peak force values. If high damping ratios are used, the general force level will then be raised greatly above that created by the inertia values, and this condition will exist throughout the speed range.

Figs. 7 and 8 are plots of relative maximum force against cam speed for the sliding and swinging followers, respectively. The peaks appearing at various speeds are caused by follower resonance. These curves follow the expected force patterns closely. In general, the cycloidal profile produces slightly lower peak forces than do the other profiles. The effects of damping are clearly shown in these charts. For an undamped system, the peak forces should be in the ratio of parabolic to harmonic to cycloidal—2.4:2.0:1.4; however, the peak velocities are in the ratio of 1.3:1.0:1.3, and the forces due to any damping become a greater part of the cycloidal or harmonic total force picture than of the parabolic total force. This can easily be seen by adding the values directly; then the figures become 3.7, 3.0, and 2.7, respectively, and a slight increase in the values will affect the cycloidal the most, and the parabolic the least of the three. As the general force level is raised slightly, the three curves shown in Figs. 7 and 8, become closer together, in the condition illustrated.

Attempts were made to discover differences between the shapes of the curves made with the sliding and swinging followers during the tests. Previous calculations made for parabolic and harmonic cams and a follower swing of 60 deg showed peak force differences from theoretical of 20 per cent less and 40 per cent greater, respectively. The actual test curves showed no detectable difference in shape as produced by the two followers. This it is felt was due to a smaller total swing of 30 deg, and the difficulty of determining accurately an absolute mean stress value from the test curves.

CONCLUSIONS

The test results show clearly that the cycloidal profile has at least two obvious advantages; they are:

1 The peak forces produced are generally slightly lower than those produced by the other profiles.

2 The oscillatory forces produced are much smaller in amplitude than those produced by the other profiles. This should permit higher machine speeds without excessive vibration and should make both cams and followers wear longer in service.

The maximum pressure angle for the cycloidal profile is greater than that for the harmonic curve, other dimensions being equal. This should mean that more power is required to drive the cycloidal cam. However, it can easily be seen from the curves in Figs. 6(*a*) and 6(*b*) that the instantaneous force

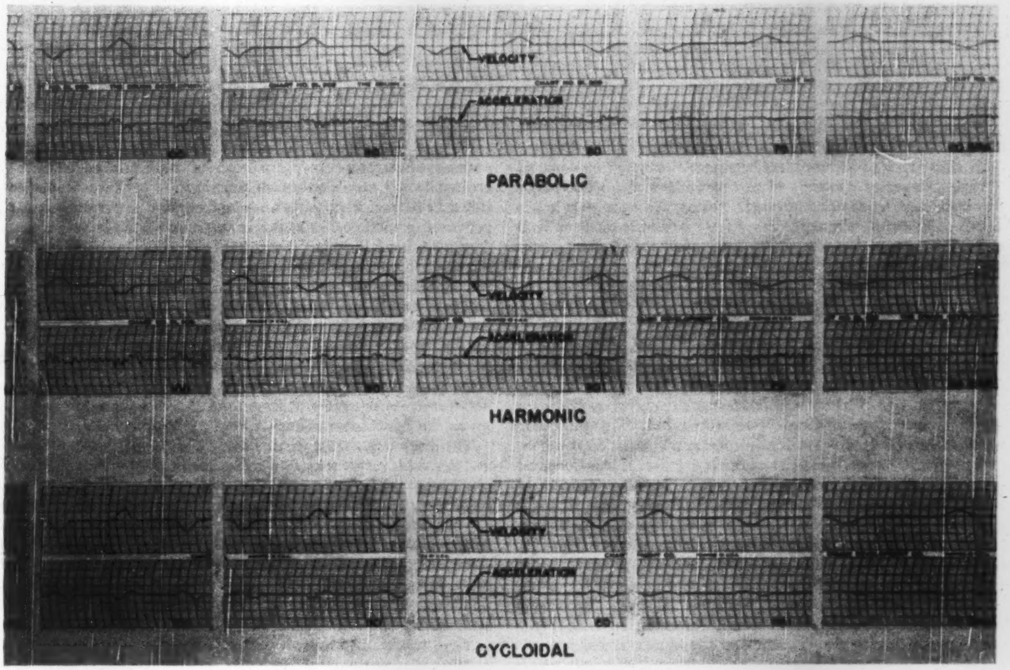

FIG. 6(*b*) FOLLOWER VELOCITY AND ACCELERATION VERSUS TIME AT FIXED SPEEDS

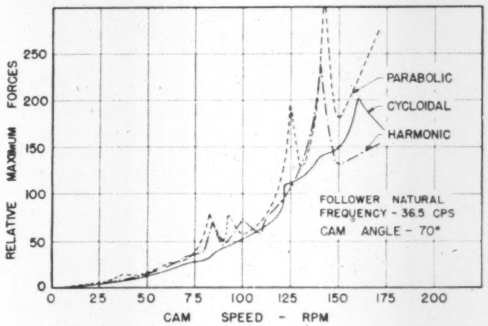

FIG. 7 RELATIVE FORCE ON FOLLOWER VERSUS ROTATIONAL SPEED FOR CAMS WITH SLIDING FOLLOWER

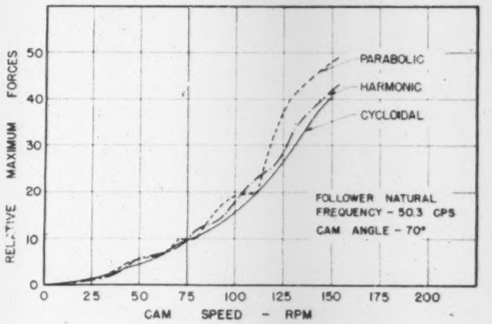

FIG. 8 RELATIVE FORCE ON FOLLOWER VERSUS ROTATIONAL SPEED FOR CAMS WITH SWINGING FOLLOWER

velocity, or power, product at the mid-point of index will only be greater for the cycloidal when no follower oscillations are taking place in a comparable harmonic cam. The test results show that this is seldom the case. Furthermore, it is usually possible to increase the size of a cam when making a design so that the pressure angle can be reduced to any desired value.

A most important point in the reduction of oscillatory forces when using any type of cam profile is the construction of the follower system. This should be made as stiff as possible with as low a mass as possible. In special cases where a system having an unavoidably low natural frequency must be used, damping may be introduced into the follower system itself, but never between the follower system and the machine frame.

Extreme accuracy of machining is required to effect true cam profiles of any pattern. This is especially important in the case of the cycloidal cam where a definite rate of application of acceleration must be produced. Since the other profiles produce an instantaneous acceleration before and after a dwell, which is the worst possible physical condition, slight inaccuracies in machining will not be particularly harmful.

The work reviewed here will be continued with the study of more refined profiles and pressure-angle effects.

SOME NOTES *on* PATENT LAW

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IN this paper an attempt has been made to touch on some of the important elements of the patent-law field, but many more have gone unmentioned. Whenever a problem arises in this field, before the application for a patent is made as well as when litigation follows the issuance of a patent, always consult the very best patent attorney available. Cheap advice can be very expensive.

BASIC PATENT RIGHTS RESIDE IN CONSTITUTION

In Article I, Section 8, of the Constitution of the United States, it is provided: "The Congress shall have Power . . . To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries . . ." This provision is the basis of federal jurisdiction over patents and copyrights, and pursuant to the authority therein delegated, the Congress has passed statutes governing these fields. A closely allied field is that of trade-marks, but the Federal Government was not granted exclusive control of this field by the foregoing Constitutional provisions. Federal jurisdiction in trade-marks must be based on some other clause in the Constitution, such as the interstate commerce clause.

A basic distinction between a patent, a copyright, and a trade-mark, is that a patent protects an invention or discovery, a copyright protects literary creations and works of art, while a trade-mark protects the name or emblem affixed to goods which are sold.

WHAT CONSTITUTES AN INVENTION?

United States Code, title 35, Sec. 31, states:

"Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, or who has invented or discovered and asexually reproduced any distinct and new variety of plant, other than a tuber-propagated plant, not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than one year prior to his application, and not in public use or on sale in this country for more than one year prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor."

It will be noted that the statute requires an invention or discovery. Although often used synonymously, these words may be distinguished by using invention to refer to mechanical devices, and by using discovery to mean the observation of some principle or effect which has been in existence before but which was unknown.

The statute does not, and as a practical matter could not, state precisely what an invention is. That is largely left to the courts to decide on a case-by-case basis. In Kirsch Manufacturing Company v Gould Mersereau Company, Inc., 6 F. 2d 793, Judge Learned Hand said, "An invention is a new display of ingenuity beyond the compass of the routineer, and in the end that is all that can be said about it." A mere mechanical improvement which the average person skilled in the trade could have developed is not patentable. Nor can a mere change in the number of parts or a substitution of materials be patented, ordinarily. A combination of parts which produces a new result may be patented, but a mere aggregation of parts, each part performing its function as before with no joint action between parts, is not patentable. An example of an aggregation is a lead pencil with an eraser on one end. Each part does the same work it did before, without co-operation. This aggregation was patented as a combination, but the patent was invalidated in Reckendorfer v Faber, 92 U.S. 347, and the court said, at page 357, "The combination, to be patentable, must produce a different force or effect, or result in the combined forces or processes, from that given by their separate parts. There must be a new result produced by their union; if not so, it is only an aggregation of separate elements."

The discovery that a particular substance will produce a new and desirable result may lead to an invention, but the discovery itself may not be patented. Dr. Morton's patent for the discovery of the effect of sulphuric ether in producing insensibility to pain was declared void in Morton v New York Eye Infirmary, Fed. case No. 9,865. The court held: "In its naked ordinary sense, a discovery is not patentable. A discovery of a new principle, force, or law operating, or which can be made to operate, on matter, will not entitle the discoverer to a patent. It is only where the explorer has gone beyond the mere domain of discovery, and has laid hold of the new principle, force, or law, and connected it with some particular medium or mechanical contrivance by which, or through which, it acts on the material world, that he can secure the exclusive control of it under the patent laws. He then controls his discovery through the means by which he has brought it into practical action, or their equivalent, and only through them. It is then an invention, although it embraces a discovery."

Another element pointing toward invention is the commercial success which has attended the sale of the article. This becomes important when the patent is involved in litigation. The patent may involve a new method of achieving a result which has long been reached by other means, but if the patented article becomes widely used, that factor will point toward invention when the patent is questioned in court.

The question of what is invention is largely, in the end, uncertain. The court must make the final decision, and, in recent years, the standard of invention has been raised considerably.

TO BE PATENTABLE AN INVENTION MUST BE REDUCED TO PRACTICE

A further requirement for a patent is that the invention be new. In other words, it is essential that the subject of the patent be novel. An invention is not novel, by statutory provision, if it was known or used by others in this country before the date of invention by the applicant or patentee; or if it was patented or described in any printed publication in this or any foreign country before the date of invention or more than one year before the application for a patent; or if the invention was in public use or on sale in this country for more than a year before the application was made. (Before August 5, 1939, the one-year periods referred to were two-year periods.)

The date of invention ordinarily refers to the date when the idea was reduced to practice, but it may mean the date when the idea was first conceived, if that can be proved, and if the idea was diligently reduced to practice. The date of patent application is the date when the complete application is received and filed by the Patent Office.

Prior knowledge or use, to anticipate an invention or to invalidate a patent, must have been in the United States. An American may independently develop an invention which has been known or used abroad, but he may still obtain a patent, subject to the other statutory restrictions. A patent will not be invalidated because someone in the United States once thought about the same idea, if there was no reduction to practice, nor is it ordinarily fatal if the same invention has been accidentally discovered and used but unappreciated by its prior inventor, since it is the patentee who benefited the public by disclosing his invention.

It is possible that a patent may be granted for an invention, even though the same invention has been patented previously or described in a printed publication. This may happen through an oversight on the part of the Examiner in the Patent Office, and, even though a patent has been issued to the subsequent patentee, it can be invalidated by appropriate action.

For prior publication to anticipate an invention, the essentials of the invention must have been disclosed, a d the publication must have been available to a large group, even though not to the public generally.

The claim of public use may be met by the defense of experimental use. In Elizabeth v Nicholson Pavement Co., 97 U. S 126, a borderline case, the inventor of a new kind of paving with permission laid a section of the pavement as a part of a road traveled by the public, in order to test its usefulness, and this was held experimental use, although used for six years by the public before a patent was applied for, so the patent was valid.

A sale under the statute does not mean a sale of the invention itself, but rather a sale of some article embodying the invention.

As a general rule, only the first inventor is entitled to a patent, but the rule is subject to certain exceptions. If someone in China two thousand years ago developed a process which became lost in the intervening time, an inventor in the United States who rediscovered the process could patent it. Or someone might invent a device and later abandon it or use it secretly, and the same device might be developed later independently by another inventor; the latter would be entitled to a patent, since he has given his work to the public.

If two persons claim the same invention, the Patent Office will declare an interference and decide the priority of invention under the Rules of Practice, with the right of appeal to the courts. The Patent Office may declare an interference where two patent applications are pending for the same invention, or where a patent has been issued and an application for a patent on the same invention is filed within a year after the first patent was issued. While the Commissioner of Patents cannot cancel a patent, he may, under Rule 93, grant a second patent for the same invention to a person who has been proved to be the prior inventor. If two patents claim the same invention, the interference may be tried in court.

One further requirement for patentability is utility. The invention must do something beneficial. If it can be used solely for an illegal purpose, it cannot be patented. The invention must be capable of performing some function, although it need not be perfect.

CONTRACT BETWEEN INVENTOR AND GOVERNMENT

A patent may be thought of as a contract between the inventor and the Government. In consideration of the inventor's disclosure to the public of his invention, the Government grants him an exclusive monopoly for seventeen years, during which time the inventor may use his invention or not as he chooses but he may prohibit others from using it. After the expiration of the seventeen-year period, the invention is open to the public for general use.

Only the actual inventor is entitled to a patent. If one person finances the work of another and an invention results, only the inventor is entitled to apply for a patent. If one person has an idea but the services of another are necessary to reduce the idea to practice, only the person who conceived the idea is entitled to a patent. If two or more persons jointly apply for a patent, each must have contributed to every claim of the patent in question, or else separate patents must be taken out by the persons inventing each claim. Where an employee is working for a corporation under a contract whereby his inventions are to become the property of the corporation, the employee making the invention must sign the application for a patent, and if anyone else does so, the patent will be invalid.

In the absence of any contract giving the employer any right in the inventions of his employees, there are two common situations. The employee may develop an invention on the employer's premises, using the employer's time and tools, and in this case, where the invention relates to the employer's business, the employer usually acquires a shop right. This means that the employee has a right to the invention, but the employer has a license—a personal right which is not assignable and not exclusive—to use the invention in his business for the life of the patent. If the employee develops an invention on his own time, using his own materials and tools, then he alone has a right to the invention, as a general rule, and may even sell the idea to a competitor of his employer.

For an employer to be entitled to the inventions of his employees, there must be a contract specifically providing for this, or else the employee must have been hired for the purpose of inventing. Even here, however, the invention must be in the line of company business, else the employer will have no claim on it.

THE PATENT APPLICATION

A patent application consists of the petition requesting a patent; the specification describing the invention and listing the claims made for it; the oath reciting that the affiant is the first and only inventor, and so on; and the official filing fee.

United States Code, title 35, sec. 33, requires that before an inventor shall receive a patent, he must file in the Patent Office a written description of his invention or discovery, and of the manner and process of making and using it "in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same; . . . and he shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery."

The description must make a full disclosure of the nature of the invention so that one skilled in the art can reproduce it or use it, but the description need not be intelligible to the ordinary layman. The claims are the basis of the inventor's monopoly. They define the invention and the protection granted, but each claim is separate and independent. A drawing must also be submitted where the invention can be illustrated, and the size and kind of paper, the type of ink to be used, and so on, are all specified by the Patent Office.

When the application is received by the Patent Office, it is filed and assigned to the appropriate division concerned with this particular subject. When the examiner of the division reaches the application, he examines prior patents and literature and rejects any claims he feels are not justified, either because of prior patents or publication of the idea, or because the claims do not define the invention properly. After making his decision, the examiner notifies the applicant of his action, and the applicant has six months in which to reply, unless the examiner has set a shorter time. If the inventor chooses to rely on his original claims, he may do so; or he may cancel or amend the claims to which the examiner objected. Whether the claims are allowed by the examiner or by a higher tribunal on appeal, the patent will issue on the payment of the final fee. The final fee is the same as the fee paid at the time application is made for a patent: $30.00 plus $1.00 for each claim in addition to twenty, except in design patents. (Design patents are issued for "any new, original, and ornamental design for an article of manufacture. . . " under U.S. Code, title 35, Sec. 73, and are granted for the term of 3½ or 7 or 14 years, as the applicant may elect.)

PUTTING THE PATENT TO USE

After a patent has been issued, the problem arises as to what to do with the invention. The patentee need do nothing with it, but if he desires to profit by his invention, he will probably want to use it himself, or else he will want to allow others to use it under certain conditions. The patentee may desire to assign his rights to another by either a total or a partial assignment, that is, he may assign his entire rights or he may assign an interest in the patent, as a 1 per cent or 90 per cent interest. In the absence of an agreement to the contrary, the owner of a 1 per cent interest has just as much right to exploit the invention as the owner of a 99 per cent interest, or as the patentee himself. Assignments are provided for by statute, but the statute (United States Code, Title 35, Sec. 47) further provides:

"An assignment, grant, or conveyance shall be void as against any subsequent purchaser or mortgagee for a valuable consideration, without notice unless it is recorded in the Patent Office within three months from the date thereof or prior to such subsequent purchase or mortgage."

Under this provision, a subsequent purchaser for value and without notice of a prior assignment which has not been recorded at the time of the second assignment will, nevertheless, get nothing if the prior assignment is recorded within three months of the time when it was given.

The patentee may, instead of assigning an interest in the patent, grant a license to use the patent. A license need not be recorded for a subsequent transferee of the patent to take subject to it. A license may limit the use of the invention in a number of ways. A nonexclusive license allows the patentee to exploit the invention himself or to license others to do so in addition to the first licensee. The license may be limited to a certain area or it may embrace the United States or the world, if foreign patents are contemplated. The license may restrict the licensee to a particular use, rather than allowing every use possible. A license may be limited in time for any period up to the life of the patent. It may require exploitation of the invention on penalty of forfeiture if this is not done. Such a license is a contract, and should be drawn carefully by a competent attorney specializing in patent problems, if the patentee wants to protect his rights.

An implied license is possible under some circumstances. One example of an implied license is a shop right, discussed in a previous section. Another instance where an implied license may arise is where a patentee sells a device to a customer, knowing the customer intends to use the device to make an article covered by the patent, and here the patentee may be estopped to deny the purchaser the right to make such use of the device for such purpose.

PROTECTION GIVEN A TRADE SECRET

Instead of securing a patent, an inventor or discoverer may rely on the common-law concept of trade secret. If an inventor uses his invention in secret, he may by injunction prevent others from using the invention, if they acquired their knowledge through a confidential relationship. If the invention is independently discovered or otherwise made public, the right to protection is gone. A manufacturing company may maintain its process as a trade secret rather than patent it, but if the process is not actually kept secret in so far as possible—as by warning employees not to divulge the process and by keeping visitors out of the plant—then it probably will not be entitled to protection if an employee leaves the company and decides to use the process himself. The protection given here is much less than is given a patentee, because the basis of the patent system is the benefit the public acquires by the inventor's giving his information to the world, and the man who wants to keep his knowledge secret deserves less protection.

FAMOUS PATENT LITIGATIONS

The following cases are well worth reading, either for the principle, the parties, or the inventions involved.

De Forest Radio Co. v General Co., 283 U.S. 664. A patent issued to Langmuir for exhaustion of occluded gases in a vacuum tube was declared invalid, partly on the ground that De Forest had anticipated him.

Edison v American Mutoscope and Biograph Co., 151 Fed. 767. This case involves Edison's patent for a kinetographic camera.

Edison Electric Light Co. v Novelty Incandescent Lamp Co., 167 Fed. 977. This case involves Edison's patent for a leading-in wire for incandescent electric lamps.

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Re-Examination of THERMODYNAMIC FUNDAMENTALS

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INTRODUCTION

IN the course of the centuries man has succeeded in classifying observed phenomena into large groups—social, psychological, biological, chemical, physical. In this same order man has succeeded in describing these phenomena with increasing precision on the basis of a decreasing number of more precisely stated postulates.

The first physical phenomenon to yield to such precise postulational treatment was geometry. The simplicity and beauty of this treatment makes it the first example the young engineer (and others) encounters in his educational career—back in his high-school days. This does not mean that all such phenomena are now logically ordered and predictable. There is always the fuzzy edge. Even mathematics—the queen of logical sciences—has some unsettled and embarrassing unanswered questions at its very foundation. Geometry, as an organization of physical facts—while the most mathematically perfect physical theory—has left a number of variously interesting, intriguing, and sometimes embarrassing questions unanswered. Thus geometric questions need continuous re-examination.

Mechanics perhaps stands next to geometry in the simplicity of postulates and the precision of description (i.e., prediction) of the appropriate physical phenomena. Newton's laws describe a precise relation between "forces" and the "rate of change of momentum." Although the concepts of force, mass, velocity, and time are not too precisely definable and, in fact, in relativity theory have undergone modification, the engineer uses them so constantly that they are accepted without question.

Theoretical work as recently announced by Professor Einstein and subsequent experimental verification have as a fundamental aim the clarification of the exact significance of and relations between space, time, mass, energy, and momentum. The engineer in his present scale of operations, confined as they are to low velocities (relative to the speed of light), and to this planet (rather than to large sectors of the universe), can remain an interested (or perhaps uninterested) bystander.

CONCEPT OF FORCE

Let us examine the concept of force. Our most immediate perception of force is obtained through our kinesthetic senses of touch and muscle strain even though this is only qualitative. These tell us that we must apply a force if we wish to raise a "weight." Directly they tell us no more. At this point we make a form of mental extrapolation so common in developing our understanding of nature. Since horizontal forces must be equal and opposite if motion is not to result, we suppose this to be true of vertical forces also. It follows that something must be pulling our weight downward, a pull which we term gravitational attraction. Does such a force really exist? We continue to believe so since many useful results are obtained and no contradiction has yet been encountered.

In a similar manner we extend the idea of force to all manner of phenomena—springs, electrical phenomena, magnets, surface tensions, stresses in structures, and pressure in fluids. Once the idea of the existence of a gravitational force is established in our minds, it is an easy matter to establish a unit of force as the gravitational pull (weight) of a given mass at a given location, thus making quantitative measurements possible. Such a unit of force is unique in that it immediately establishes the method of measurement of all forces in any kind of situation. In particular, it is easy to visualize, measure, or apply two units of force. This specification of a scale of measurement may not sound very remarkable—it is common to length, time, and the like—but as we shall see it is not so easily accomplished for temperature.

NEWTON'S GENERALIZATION OF MECHANICAL PHENOMENA

Once the idea of force was firmly established, the way was open for Newton's grand generalization of mechanical phenomena embodied in his three laws. While these laws can answer all questions of mechanics, another idea took shape and suggested further generalization. The study of forces on levers, pulley and rope systems, and other simple mechanical devices showed that the product of a force by the distance through which it moves is constant. This product, called the work done by the force, was such that if it is positive at one end of a frictionless pulley system, it is of the same magnitude but negative at the other. We generalize this idea by supposing that if work is done at one place on a frictionless mechanical system, an equal amount of work will be done by the system at another. Thus something appears to be transferred in at one place and an equal amount transferred out at another.

In attempting to apply this idea of "work done" as a transfer of something (we call it energy) from one place to another, various difficulties are encountered. If a spring is stretched, work is done on it, but where does the spring do an equal amount? Again, when raising a weight, where does the energy go? That it is not lost is evident since the reverse motion of the system returns the work in its entirety. The energy must have been stored somehow in the elastic stretch of the spring or the vertical position of the weight. If our idea of energy is to apply to these cases, we must imagine a storage possible, and we thus "invent" the idea of potential energy; the potentiality of the system to return energy to us in the form of work. Thus are invented the stored elastic energy of structures, the energy of the gravitational field, electric field, or magnetic field.

Our difficulties are not over. When we let go of a weight it moves spontaneously downward. If our developing-energy concept is to be preserved, we must note that the gravitational potential is decreasing without giving us any work. Where does the energy go? Perhaps into energy of motion. The answer to this problem must be given by Newton's laws since they accurately describe all mechanical effects. We find from these laws that the energy of our system is preserved if we agree to recognize $^1/_2 mV^2$ as a form of energy—obviously to be called "kinetic energy."

Still our difficulties are not over. Two mechanical phenomena still remain to be brought within our energy concept if it is to be universal:

1 What happens to the energy of the dropped weight when it collides with the floor? Any system with friction raises this question since the work done on the bodies appears neither as recoverable potential energy nor as kinetic energy. Mechanically speaking, the energy is gone.

2 What happens if, after stretching our spring, someone heats it, thus changing its spring constant? When the heated spring is returned to its equilibrium position we may get either more or less work than we put in. Such changes are possible with any potential-energy storage system whose properties change with temperature.

EFFECT OF THERMAL PHENOMENA

No further generalizations of the idea of energy are possible within a mechanical system. Preservation of our conservation law can only be possible by including thermal phenomena.

The way for the final generalization was disclosed by the study of thermal phenomena. There thus developed thermal ideas paralleling the mechanical ones. The experimenter immediately encounters some more serious difficulties in a thermal system. Thermally, as well as mechanically, our sense organs give us qualitative facts. We note that ice is uncomfortably cold, while boiling water is uncomfortably hot. We do not, however, find any phenomenon like gravitation for forces which permits us to define a unique unit of hotness. Nevertheless quantitative progress can be made by observing that certain phenomena depend primarily upon the hotness, and these are used to construct a temperature scale. Thus the expansion of liquid mercury relative to a glass bulb is often convenient, but such thermometers are purely arbitrary. They depend upon the particular properties of particular substances chosen for the thermometers. The setting of a scale like 0 for the ice temperature and 100 for the steam point tells us nothing about the meaning of 200 deg or 50 deg. Extrapolation and interpolation depend only upon the arbitrary thermometer selected. We need some unique thermal phenomenon before a unique scale can be defined.

Regardless of scale troubles, much can be learned and in fact was learned by mixing experiments, and by heating and cooling experiments, using some arbitrarily selected thermometer. It was observed, for example, that if ice is dropped into boiling water, the ice warmed up and the water cooled down to an intermediate temperature. Almost always on mixing materials, they arrive at an intermediate temperature which is closest to the material used in largest bulk. The more boiling water the hotter the mixture. There are some awkward exceptions—mixing sulphuric acid and water, for example—where the mixture temperature is above or in some cases below that of either component. Temporarily ignoring the exceptions, however, mixing experiments suggest two generalizations: (1) All bodies tend to a common intermediate temperature when in thermal contact. There is a thermal equilibrium toward which bodies in contact move spontaneously. (2) It appears that something is transferred from one body to another during this temperature-equalization process. This something transferred was once supposed to be a tenuous fluid called caloric and, since this is an entirely adequate idea in so far as purely thermal experiments are concerned, we will for the moment do likewise.

First we need a scale for caloric. Since thermal mixing experiments show that different bodies hold different amounts of caloric—have different capacities in the sense of a bucket—we can select one of these bodies as defining the unit. For example, we can select the amount of caloric required to heat 1 lb of water from the ice point to the steam point as our unit. In fact, $^1/_{180}$ of this is a mean Btu (180 = 212 — 32). We note that in spite of the fact that we have not succeeded in establishing a temperature unit that can be doubled, we have no such difficulty with our unit of caloric. It is obvious that two units of caloric will raise 2 lb of water from the ice to the steam point, and so on.

With a well-defined caloric scale available, we can determine the heat capacity of many different substances over many different ranges of temperature. We learn that to change the phase of a material (ice to water, water to steam, and so forth) requires considerable caloric without a change of temperature. Thus there is a "latent" heat of fusion or vaporization. There appears to be caloric stored in water at 32 F which is not in ice at the same temperature. Thus, within thermal experiments, the fluid caloric is conserved.

Let us now consider the two types of experiment which led to difficulties with our mechanical-energy idea. In the friction experiment, mechanical energy disappeared and the rubbed bodies got hot. Thus caloric is manufactured by the mechanical action. In a mechanical-friction experiment then, we have a loophole in our conservation of mechanical-energy concept, and a loophole in our caloric concept. To us it appears obvious that we can plug both loopholes at once by simply supposing that caloric and energy are different aspects of one and the same thing. That this was not easy, however, is attested by the history of the many years required to bridge this gap.

CONSERVATION-OF-ENERGY CONCEPT

We thus arrive at a very general conservation-of-energy concept which encompasses thermal and mechanical effects. We should note that mechanical effects include electrical phenomena (basically defined in terms of forces between charges or magnetic poles), and chemical phenomena (in so far as thermal, mechanical, or electrical effects are concerned). Such a generalization will stand or fall depending upon the outcome of all possible experiments. If there is ever found a single violation, the whole principle is wrong. No violation within the phenomena so far discussed has been found, in spite of an enormous accumulation of experimental evidence, but there is no proof that a violation will never be found. In fact, right now there are some basic difficulties in nuclear experiments in which energy disappears (not compensated for by the appearance of any known forms of energy). The attempt to preserve the conservation-of-energy law in this case involves the supposed existence of a particle (the neutrino) not yet "discovered" in any more convincing way.

To get back to our newly formulated conservation-of-energy law, we need to fix up a few things. In the first place, we have an excess of units. For example, mechanical energy is measured in foot-pounds, our basic mechanical units. Thermal energy is measured in Btu. If both concepts are the same, one unit is enough; all units are related. To get the relation between the units we need only use the friction experiment, measuring the foot-pounds of mechanical work done and the Btu of thermal energy that appear. The early cannon-boring experiment of Count Rumford was one of the first. All friction experiments ever performed have always agreed within experimental accuracy on the correctness of the conservation-of-energy law. However, since the original definition of the Btu (the heat required to raise 1 lb of water 1 deg F) depended upon the properties of water, some experimental error was always involved in the unit definition. Thus a modern definition of the Btu has been adopted independent of such properties by defining 1 Btu as equal to 778.26 ft-lb.

Friction experiments alone are enough to suggest the extension of the concept of conservation of energy and the definition of a universally usable unit of measurement. They are also enough to suggest that in any given change of state, a body must, in general, change its content of energy. Just as at high temperature a body contained a lot of caloric, now it must contain a lot of energy, and this energy must be a unique function of the state of the body (not dependent upon how the body got into that state). Since, however, work as well as heat transfer can change the state of a body, we must now define the internal-energy change between any two states as the sum of the heat transferred to the body and the work done on the body.

THE HEAT ENGINE

Now consider the second type of connection between mechanical and thermal energy, namely, the heat engine. Our elementary example is the spring which is first stretched, then heated, then released, and finally cooled to its initial state. All work transfers may have been made without friction (thus reversibly). The net work transfer may have been either to or from the spring. Thus in this second type of failure of the mechanical-energy law, we appear to have the possibility of creating mechanical energy as well as destroying it. Friction, we learn by experiment, can only destroy mechanical energy. What does our law of conservation of energy say about such a cyclic process? Since the spring is identically the same at the beginning and end of the cycle, our law says that the spring has the same internal energy at both times and hence the net mechanical energy produced must equal the net thermal energy destroyed. It says no more, but, most important, what it does say is true. Experiments on cycles verify precisely this prediction of the first law of thermodynamics—the law of the conservation of energy. This might not have been so but it is. By ascribing the errors of mixing experiments to chemical action between the mixed fluids, all physical phenomena have been brought under the sweeping generalization of the "first law of thermodynamics." Thus, with the possible exception of a few nuclear phenomena, there are no experimental results which fail to agree precisely with this law.

This does not mean, however, that now all is well—that now we can predict precisely what will happen in all thermal-mechanical systems. In fact the first law fails completely to accomplish the following:

1 Help us in any way to find any phenomenon which is uniquely dependent upon hotness only. Thus we still have only an arbitrary temperature scale dependent upon the phenomenon selected for our thermometer.

2 Give any indication whatever why mechanical energy can be transformed at will into thermal by friction while the same process cannot be reversed.

3 Tell us why every cycle we invent must work between two temperature levels, absorbing heat at the higher and rejecting heat at the lower. We remain thus uninformed about the efficiency of transformation of thermal into mechanical energy (efficiency being defined as the net work done divided by the heat supplied at the high temperature). (If the efficiency were defined as the net work done, divided by the net heat added, it would always be unity by the first law.)

For many years men got along as best they could with the following:

1 An arbitrary thermometer.

2 The general adage that friction is bad.

3 Empirical data on engine efficiencies. (Formerly efficiencies were mysteriously low; today they are still rather low but we know why and what is involved in making them better.)

THE SECOND LAW OF THERMODYNAMICS

These three effects are not obviously closely related. They do not supply us with a broad hint of the underlying principle, nor even suggest that one exists. It is for this reason that the second law of thermodynamics was slow in being formulated, is more difficult for both students and mature men alike to comprehend, and is the law most willingly violated by those who would build perpetual-motion machines.

The only hint of the possible formulation of another principle to govern thermal phenomena is the fact that heat always passes from the hotter to the colder body—never the reverse. It is of course only for this reason that we find thermal equilibrium possible in this world. However, it is not obvious that this observation either should or could be generalized any more than the observation that friction is bad.

Clausius did see that something could be gained and thus stated the generalization: "It is impossible to construct a device which, operating in a cycle, will produce no effect except a transfer of heat from a lower to a higher temperature." In thermal mixing experiments it is obvious that this is so. Our generalization is merely the assumption that nature does not so transfer heat directly and cannot be tricked into doing it by any amount of gadgetry. The success or failure of this law—just as the first law—depends completely upon the experimental correctness of its predictions. One phenomenon violating any one prediction is enough to ruin the law. To date no failure has been found although thousands of consequences have been examined.

The most important direct application of the second law of thermodynamics is to heat-power cycles but before discussing this we must consider the make-up of such cycles more carefully. If we return to our spring, we note that, depending upon the thermal surroundings and the manner of load application, we can perform all kinds of cycles. There is one kind of cycle, however, that we can always perform in principle. This is a cycle consisting of an isothermal heating (work done if necessary), a reversible adiabatic work output, an isothermal cooling, and a reversible adiabatic work input. Isothermal processes can be performed accurately without involving a temperature scale, merely by the use of a large heat reservoir. An adiabatic process (a no-heat transfer process) can be performed without involving any temperature scale by the use of adequate thermal insulation. The question of whether the adiabatic work process can be performed equally well in either direction (reversible process) is more difficult but can always be answered in the affirmative at least in the idealized case where mechanical friction is negligible. This cycle, called a Carnot cycle, is reversible in all its parts and, therefore, is completely reversible in all its external effects; it will run as a heat engine or a heat pump equally well.

If now two engines, one a Carnot engine, are operated between the same two temperature reservoirs, we can see that, if both deliver the same work, the other engine must use the same or more heat from the high-temperature reservoir. If this were not so, we could use the work from the other engine to pump heat from the lower to the higher temperature by reversing the Carnot engine. This would constitute a trick system in violation of the second law. Thus the second law serves to show that the Carnot cycle (or any reversible cycle operating between the same two temperature limits) is unique among cycles, in that it absorbs the minimum amount of heat to produce a given work when rejecting heat at a given temperature. This is what we have been looking for—a phenomenon which depends uniquely upon the hotness. We use this unique property to attach labels to the isothermals.

DEFINITIONS—ISOTHERMALS AND TEMPERATURE—ADIABATICS AND ENTROPY

We select some temperature as a unit temperature and define any other temperature as "the heat used at this temperature by a Carnot cycle which transfers unit heat at unit temperature." This is the so-called "absolute" temperature scale; it does not depend upon the properties of any particular substance. At a room temperature of 540 F abs, a Carnot cycle which absorbs 540 Btu would reject 1 Btu at 1 F abs, and supply 539 Btu of work. Our unit temperature is of course still arbitrary but, having chosen a unit, we now have no trouble in doubling it. The scale is fixed, clear, and unique. It is interesting to note that our temperature thus defined is closely related to the energy unit as is also the case in the kinetic theory. The usual Carnot efficiency formula in terms of the high and low temperatures follows immediately from this definition.

Those engineers who, as students, have been subjected to a detailed development of these ideas, have usually followed the arguments to the point of getting a unique scale for the isothermals. However, the introduction of something called entropy, often remains mysterious. This should not be the case, since the basic ideas are no more difficult nor obscure than the naming of the isothermals. A Carnot cycle consists of two isothermals and two reversible adiabatics. The cycle, therefore, serves to give names to the reversible adiabatics as well as to the isothermal lines. Any number that can be assigned uniquely to the reversible adiabatics will do for a scale. We will choose one. We have already set a unit of temperature. On this unit isothermal, we choose a standard state—a particular reversible adiabatic to be called the zero adiabatic. This is done arbitrarily. All other reversible adiabatics are named by the amount of heat which must be added at the unit temperature to reach the chosen reversible adiabatic from the zero adiabatic. The heat added at unit temperature is called the "entropy."

From this definition it is clear that each reversible adiabatic change of state, which can now be called an "isentropic change of state," has a unique name; that the entropy is a state function (a physical property which has a unique value at each state), and that it can be determined in principle by simple heat-transfer measurements. In practice, of course, it is much more convenient to determine the change of entropy by measuring the heat added on some arbitrary isotherm between the desired reversible adiabatics, and to divide this heat absorbed by the absolute temperature (which, by the foregoing definition of temperature, gives the heat added on the unit isotherm between the same isentropics). All of the usual thermodynamic relations now follow from these definitions with the aid of some algebra and calculus—a task not to be undertaken here.

We should note, however, that while we have arrived at a simple, practical, experimental scheme for measuring entropy (assuming the absolute temperature as known), we do not yet have a practical scheme for measuring the absolute temperature itself because it involves the operation of a Carnot cycle to the unit isotherm to ascertain that unit heat is rejected there. The method of approach to the circumvention of this difficulty is typical of the simultaneous development of our concepts and experiments in the exact sciences.

COMPUTING ABSOLUTE TEMPERATURE

As a result of the foregoing theory, we have developed ideas consistent with all the available experimental data except that the most useful process (a Carnot cycle) for defining the temperature is not a simple experiment. In fact, it is generally impossible experimentally to get a sufficiently precise approximation to the reversible adiabatic. What can we do? As I have said, the approach is typical. We derive all the consequences of our theory that we can. Any one of these derived formulas which contains the temperature is a potential source of the determination of the temperature. Thus if all other quantities in the derived relation are measured, the absolute temperature can be computed. Unfortunately, most of the derived relations involve derivatives of the temperature so that an integration is necessary.

For a few special substances, the absolute temperature appears directly in some of the relations between their properties. Thus the ideal gas—which all gases approach at sufficiently low densities—has a pressure-volume product proportional to the absolute temperature. It is for this reason that the ideal gas thermometer has been used extensively to calibrate ordinary thermometers with an absolute-temperature scale. Black-body radiation is, in a thermodynamic analysis, as much of a "substance" as any other and follows the thermodynamic laws. Among these is the fact that the internal energy per unit volume is proportional to the fourth power of the absolute temperature. This is used in radiometers for furnace temperature measurement.

CONCLUSION

From this brief re-examination of the arguments which lie at the foundations of thermodynamics, we see that all equilibrium thermal phenomena have as sound a basis as mechanics or any other general physical law. A few basic assumptions are made, guided by some obvious physical phenomena. These few assumptions—the first and second laws of thermodynamics—are generalized by supposing that they apply to all phenomena, even though outside of those originally contemplated. This generalization is followed by the deduction of all possible consequences, and finally these consequences are checked experimentally, especially where some phenomena not already known are predicted. If in all this work no logical contradictions are encountered and no physically nonexistent phenomena are predicted, our confidence in the correctness of our generalizations is bolstered until—as in thermodynamics today—we feel very sure that no contradictory phenomena ever will be found.

We thus say with confidence that no perpetual-motion machine—no matter how complex—will ever be built which does work but eats no fuel (a perpetual-motion machine of the first kind, one that violates the first law of thermodynamics), and that no machine will be built which does work at the expense of heat extracted from a reservoir at a single temperature without rejection of heat to a reservoir at a lower temperature (a perpetual-motion machine of the second kind, one that violates the second law).

But far more important than this, we as engineers can approach our everyday work with thermal processes, engines, and the like, with confidence that our designs will not fail because of our lack of understanding of the basic laws of Nature.

You may say at this point, "But our designs do frequently fail." This sometimes is because we have failed to heed one of the well-known laws. However, it is more than likely that they have failed because of friction, viscosity, heat transfer, chemical-reaction rates, or other rate processes which, being nonequilibrium in nature, follow laws in addition to our well-established simple laws of thermodynamics and bring in new phenomena that by their complexity have not yet been adequately systematized.

Applications of a Portable CONTINUOUS SMOKE RECORDER

By E. K. VON BRAND

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THE Socony-Vacuum continuous smoke recorder was developed by the Burner Fuels Division of the Technical Service Department of the Socony-Vacuum Laboratories to meet the need for a portable instrument of sufficient accuracy and versatility for continuous smoke measurements on small installations, especially domestic oil burners.

Aside from the noncontinuous well-known testers (Shell, Bacharach, Mobilheat combustion tester, etc.), which deposit a smoke patch on a filter-paper surface, there are also numerous continuous smoke recorders employing direct photoelectric methods. Most of these photoelectric instruments are designed for the operation of stack and other combustion controls and often are used for transcribing a record onto a chart. Exacting installation requirements, lack of portability, and poor sensitivity to smoke below the visibility level are among the handicaps which interfere with the use of these instruments for testing the smoke performance of small units.

Although under equilibrium conditions of operation, spot testers are usually satisfactory, a continuously recording device presents a more reliable, uninterrupted picture of changes in smoke, notably those occurring at the start and at the end of a combustion period. For these reasons, it would seem that the Socony-Vacuum continuous smoke recorder could perform a useful function in association with other automatic recording instruments for combustion work.

PRINCIPLES OF OPERATION

This new instrument is based on the well-known principle of filtering a known volume of flue gas to obtain a soot deposit on a filter, the optical density of this deposit then being a measure of the smoke content of the entire flue-gas stream. The novel features of this design are the mechanical means which make it possible to produce a continuous trace of smoke deposits on a filter tape. This is accomplished by pulling the tape through a specially designed fixture interposed in the gas stream which is drawn continuously from the stack by a vacuum pump. The tape is kept moving by rolls geared to a synchronous motor to insure uniform speed. The varying degrees of darkness of the trace furnish a measure of the smoke conditions under which the burner is operating. While passing through the instrument, the tape is marked with a suitable time scale for the purpose of indicating the duration of the test as well as for evaluating the rate of change in smoking. For chart-recording purposes, a supplementary attachment using a photoelectric principle is connected to the tape recorder proper.

A wide range of sensitivity is obtained by providing adjustments for the flow rate of the sampling stream of gas as well as the tape speed and also, for special work, the area of tape exposed at any particular instant. An advantage inherent in these principles is the ability to produce an amplifying or cumulative effect, which is useful when dealing with low smoke densities, below the level of visibility. At present the smoke trace is recorded in two widths—$^{1}/_{4}$ in. and $^{1}/_{2}$ in.—both on tape $1^{3}/_{8}$ in. wide. A tape speed of $1^{1}/_{2}$ or 3 ipm can be selected, or, by changing the small roll-drive motor, other speeds may be obtained. The flexibility derived from these features facilitates calibration of the instrument in units of already established smoke scales.

CONTINUOUS SMOKE RECORDER IN OPERATION ALONGSIDE DOMESTIC OIL BURNER

The portability and compactness of the instrument are evident from the illustration showing it in operation alongside a domestic oil burner.

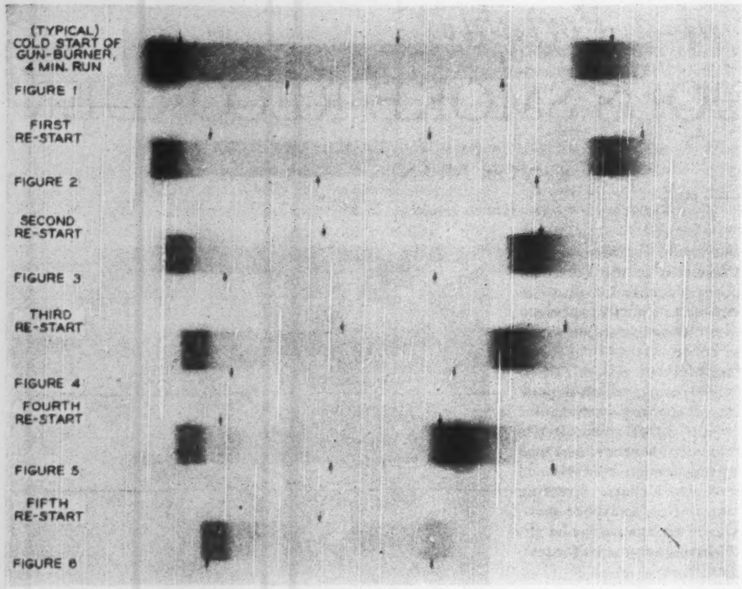
In judging the smoke records presented, allowance should be made for imperfections due to reproduction. For better visibility the time scale is indicated on the reproduction by small arrows.

TYPICAL RECORDS

Figs. 1 to 4 give an idea of smoke conditions for the start and cutoff of a gun-type oil burner, at different combustion-chamber temperatures. Fig. 1 shows a typical cold-start record of 4 minutes total duration, with a Shell-Bacharach smoke density of No. 6 immediately after the starting puff, and of No. 2 just before the cutoff smoke. The time interval between these points, as indicated by the time scale, is about 3 minutes.

Fig. 2 presents a restart, under identical conditions, after a 5-minute shutoff period. The effects of the preceding warm-up are already manifesting themselves in a general decrease in smoke. Not only are starting and cutoff smoke reduced, but the running smoke also has improved from a No. 4 to a No. 1, again during a 3-minute period.

Figs. 3 and 4 are additional restart runs of 3-minute duration made after 5-minute shutoff periods. Here the time to clear up

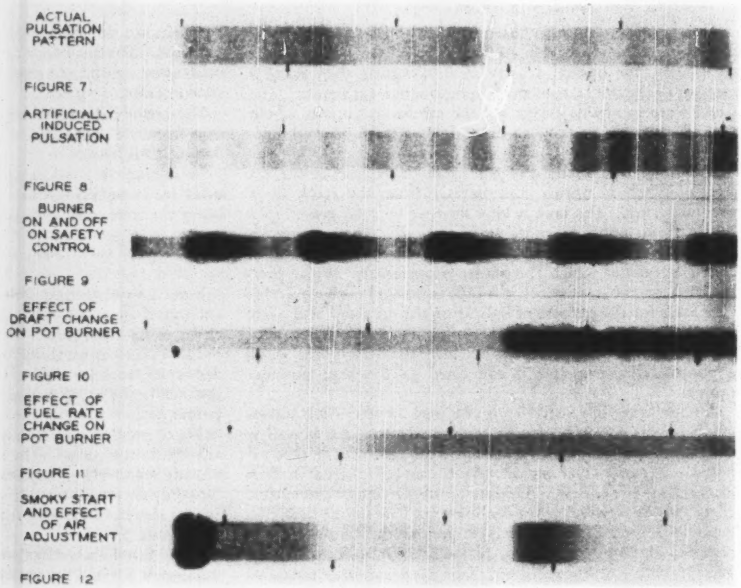


RECORDS PRODUCED BY CONTINUOUS SMOKE RECORDER

from a No. 4 to a No. 1 smoke is reduced to 2 min, as compared to 3 min for the cold start shown in Fig. 1.

This type of record may be helpful in the practical evaluation of burner installations operating "on cycle," with particular regard to the effects of combustion-chamber design and materials, refractories, etc. Records of this type could also serve as a basis for developing a standard method of comparing the rate of decrease in smoke over definite periods of time, both after a cold start or after a start on cycle.

Figs. 5 and 6 were taken for the purpose of demonstrating



RECORDS PRODUCED BY CONTINUOUS SMOKE RECORDER that cutoff smoke can be minimized by maintaining draft for a brief period after the extinction of the flame. The reduction in end smoke shown here was brought about by maintaining maximum draft through closing the stack draft regulator just before the burner shuts off. Another way of securing the same reduction would be by maintaining the combustion-air supply after the burner shuts off, for example, by a free-wheeling blower rotor. However, such measures only alleviate the magnitude of cutoff smoke, and the practice of installing a quick-acting, positive shutoff valve in the fuel line would tend to cure this difficulty at the source.

Fig. 7 illustrates the smoke pattern of a pulsating operation obtained under field conditions. The mottled appearance reflects an unstable state of the combustion process.

Fig. 8 was obtained by rhythmic variation of the air supply, resulting in what might be termed induced pulsations.

Fig. 9 shows what happens to the smoke when a burner goes off and on with safety control in action. It gives an idea of the copious quantities of soot produced if this were to continue for any length of time.

Figs. 10 and 11 were taken in connection with a pot-burner test. The rapid darkening of the trace in Fig. 10 indicates the quick response to a reduction in draft, while the gradual transition from light to dark, as shown by Fig. 11, is the result of an increase in fuel rate.

Fig. 12 is given as an example of a very smoky start of a gun burner. About 1 min after the start, the air shutter was opened further resulting in a reduction of the smoke from Shell-Bacharach No. 6 to No. 3. The end of this 3-min run again shows a typical gun-burner cutoff smoke pattern.

USEFULNESS OF SMOKE RECORDER

The sample records shown would seem to indicate that an instrument of this type may prove useful whenever a continuous trace of the smoke variable is required. Furthermore, a record including the time co-ordinate with its attendant advantages is indispensable for investigating irregular fluctuations in the rate of smoking. Recent work has shown the deleterious effect of smoke upon efficiency and, therefore, an interpretation of a continuous smoke record made in conjunction with other relevant measurements may well speed up the solution of problems in various fields of combustion.

A number of these recorders, some equipped with photoelectric facilities for chart-recording, are already in use for both laboratory and field work on oil burners, and their application to internal-combustion engines and other variable smoke sources is being considered. Further, while this instrument, suitably modified, may be adaptable to the control of processes, other than combustion, involving gases and liquids, applications of this kind are beyond the scope of this paper.

The foregoing summary of a few of the applications of the Socony-Vacuum continuous smoke recorder is intended to stimulate further progress in the evolution of the art of smoke recording from the static to the dynamic stage.

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Locomotives and Smoke in Pittsburgh

(*Continued from page 466*)

These inspectors sent to our office daily reports of the number of locomotives they had observed, the number that violated the ordinance, the number of firemen warned or instructed, and similar information. The total number of locomotives observed or checked during the year was 175,345. Of these, 358 violated the ordinance.

The crews of the 358 violators were given a separate hearing before a road foreman of engines. Of these, 139 were suspended for a few days; others received reprimands and criticisms. We have found this method extremely effective, much more so than any scheme of competition or awards among the firemen.

Violations are 0.204 per cent of the 175,345 observations. In other words, of 10,000 locomotives observed, only 21 violated the ordinance. Anyone familiar with figures of this type, will note that this is a wonderfully low figure.

If we try to compare this figure with others we find it most difficult. A few cities keep records of observations and violations but the number of records is small compared with our 175,345. And to make the comparison still more difficult, the ordinances are different.

One city published their 1948 records as follows: Total number of observations during the year, 11,300; violations, 180. This figures out 160 violations per 10,000 observations. Perhaps this might be compared with our Pittsburgh figure of 21, as the ordinance restrictions are alike in both cities. I have been told that in this particular city about 90 of the locomotives are equipped with steam jets. Inasmuch as violations are some eight times more than ours, it would seem to bear out my conclusion that a good inspection system gives far better results than steam jets.

The Pittsburgh smoke ordinance allows a locomotive to emit not greater than No. 2 smoke for one minute in any one hour. I do not know of any stricter ordinance than this. A steam locomotive that blows smoke for only 15 or 20 sec can produce a large cloud that will hang in the atmosphere a long time. Yet this is not a violation. However, the public are not interested in the technical provisions of the ordinance. They only know that they want the smoke stopped. We get many complaints that on investigation show the smoke was allowable. Wherever there are coal-burning locomotives there is bound to be smoke. All ordinances allow a certain amount.

It may be said that the public must learn to accept this situation. But Pittsburgh objected, and here is where the Diesel locomotive comes in. It really gives a clean city. All switching engines in Pittsburgh are Diesels.

I have great hopes for the gas-turbine locomotive. Perhaps it will solve the problem.

Developing PROFESSIONAL COMPETENCE *in* INDUSTRY

By J. C. McKEON

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IF INDUSTRY is to discharge its full responsibility and maintain a position of leadership in our economy, management must take a deeper interest in developing the professional competence of its people. Through the technological developments of industry, our nation has achieved a level of material progress unmatched in the world. To this achievement, engineering has made a major contribution. But our progress in the area of human relations has not kept pace with our technological advancement.

The most crucial problem facing management today is productivity. And, productivity is as much a problem of dealing with people as it is a technical problem. While industry is becoming more technical as a result of the application of science, it is, at the same time, assuming greater social responsibilities. These trends, together with the growth of business, require the services of an increasing number of engineering graduates who must have a broad professional outlook as well as technical competence. Accordingly, both industry and the colleges need to place more emphasis on the development of skills which will enable the engineer to recognize and handle human relations as well as the technical aspects of his work.

To the quality of being able to deal effectively with both the technical and the human-relations problems in industry, I have given the name "professional competence." The development of these technical and social skills requires that we give more attention to the education of the "whole man." It involves a knowledge of physical principles and their application, an understanding of human behavior, and an appreciation of the social implications of scientific work. In brief, it means the development of a good engineer and a good citizen.

The primary obligation of industrial management is to run the business so it will succeed. A business must be productive and profitable if it is to continue to produce goods and provide jobs. The greatest asset of a business is trained personnel. This, industry does not have to be told. The problem before us is, how to develop best the type of leaders so urgently needed in the shops, laboratories, and front offices. This is not an academic question. It involves very real problems which confront business leaders and educators alike. Dealing as it does with human relations, this question is at once the most intriguing, and, at the same time, the most difficult problem facing top management today.

INDUSTRY'S STAKE

Before getting into the larger problem of how to develop professional competence, let us determine if industry has a stake in such development. What does the training of the whole man have to do with productivity? Does it really pay off, or is it one of those nice things to do, if you have time and the money? Let's get down to some basic considerations in attempting to answer these questions.

When we employ a college graduate, we do not hire mechanical skill or analytical ability alone. Instead, we hire an individual with many personality traits, all of which have a bearing on his ability to do the job. As an individual, the employee does not park his human equipment at the shop gate when he reports for work each morning. He brings with him his hopes and his fears, his good qualities and his bad traits—they are all a part of him. His home life and adjustment in the community influences his work and the conditions of work in turn affect his family relations.

In our dealings with people, we have long been handicapped with the tendency to "compartmentalize" the individual. We speak of a man's technical ability and his personality. We refer to his job world and to his professional activities. We ask about his academic work and his extracurricular activities, as if they were airtight compartments rather than different facets of his total personality. Specific traits or abilities which we note in an individual do not function in a vacuum. There is no such thing as the world of work on one hand, and the outside world on the other. It is one world to the individual. Those of you who have handled difficult technical problems—problems in which something has gone wrong—will attest to the fact that their solution involved the social interaction of the total personalities of all individuals working on the project. In a complex situation, it is difficult to differentiate between the technical and the human-relations aspects of the problem.

The narrow view of the individual has led some employers to take the extreme position that the education and professional training of the young engineer are of no concern to them. Participation in engineering societies, enrollment in evening courses, and preparation of technical papers are considered strictly the business of the individual. The great majority of these employers have the best intentions in the world, but their attitude, nevertheless, discourages the young man from developing those very qualities which the company will require at a future date. Apparently, these managements are laboring under the misapprehension that the college graduate is a finished product and that managers are born.

Characteristically, the management of these companies frequently fails to delegate responsibility. Thus all the important decisions are made by a few at the top. Obviously, competent men cannot be developed in this way. What are the results of inadequate personnel development? As a rule, rather than the exception, the good jobs are filled from the outside rather than through promotion from within the company. Such a practice stifles initiative in the lower echelons. When capable young

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men observe their immediate supervisors are not progressing, they normally do one of two things. They try to get another job or they lower their sights and thus their growth.

Enlightened management on the other hand has taken a different approach. They know the value of building a strong team. They recognize that if a company is to grow, the individual members must grow. They realize that the type of leadership their companies will have in the future is dependent on the quality of the training and education their young employees receive today. By offering opportunity, these managements have encouraged capable graduates to join their companies. Through their well-planned development programs, they are giving the young men the tools they need to build a professional career. Under such a philosophy of encouraging initiative and self-development, an individual grows in stature and is thus prepared to assume a position of larger responsibility.

An effective development program in industry is like an investment. One does not start clipping coupons the day he makes his first payment. But the prudent man, who has been investing some of his money regularly, receives dividends periodically. So it is with a company. Companies which have been developing their personnel over the years are receiving a good return every day. The fact that these companies are expanding their programs is evidence of their value. The enthusiastic support given the programs by experienced employees is proof of their worth.

ESSENTIAL QUALITIES

If our task of developing professional competence is to become manageable, we must know the specific qualities which make up the type of individual we want. To get anywhere, we set our objectives. What are the qualities which make for success in industry? This is a philosophical question, and we must be careful not to give a philosophical answer, that is, if we want our answer to be useful.

Engineering Fundamentals. The first requisite for success on an engineering job is a knowledge of the science and art of the field and the ability to think clearly. The young engineer must be well-grounded in the physical sciences, mathematics, and the engineering method of solving problems. The better he knows the technical aspects of his job, the greater his self-confidence and security.

Desire to Get Ahead. Motivation is essential. Successful men have the ability to create challenges within themselves which impel them toward achievement. One's success depends, in a large measure, on the goals he sets. We can all cite cases in which a man with a purpose far surpassed others who had greater native ability.

Capacity to Deal With People. Results are accomplished through the efforts of people—people working as a team. In industry no one works alone. Dealing with people means much more than just getting along with people. It means getting the job done, but doing it in such a way that harmonious relations exist throughout the organization. Skills in human relations are, therefore, indispensable. A leader must have the power to inspire others and win their spontaneous co-operation. Charles Schwab, famed steel executive, once said, "I consider my ability to arouse enthusiasm among men the greatest asset I possess."

Adaptability. To progress, one must adjust himself to changing conditions. In part, adaptability is a result of a good fundamental education and broad experience. More than this, it is mental flexibility. It is the attitudes by which one will react positively toward assuming responsibility, learning a new skill or specialty, moving to a new position or place, and taking a calculated chance.

Emotional Maturity. This quality is significantly related to job stability and social adjustment. The ability to see human situations in their proper perspective, the capacity to think objectively on human problems, and the power of self-analysis without being unduly critical are indications of a well-adjusted person. The mature person is self-confident, but modest. He realizes he cannot always have his own way. He will stand up for his ideas, but once a decision is reached, he will carry it out to the best of his ability.

Response to Adversity. A professional career is not all smooth sailing. Sometimes, the best plans go wrong. How the individual responds to adverse conditions has a bearing on his future. A sound basic philosophy of life acts as a stabilizer when the going gets rough. The young engineer needs to realize that there are no short cuts to success in life and that the way which seems to lead to wealth and fame often proves to be a dead-end street.

Vision. Industry needs men of vision and creative ability. Men who can thrust their imagination beyond the immediate problems and grasp a vivid picture of their final achievement. Men who will stake their reputations on their well-calculated decisions. Such men develop new products, new management methods, and new business enterprises.

Business Judgment. The ability to size-up a situation, whether it involves human relations or technical factors, and reach a reasonable decision cannot be overemphasized. A professional man must constantly sift the good advice from the bad, gage the effects of outside events on the problem under consideration, and judge the probable outcome of his decisions. The engineer in industry works in a business environment and economic factors loom large in most decisions. An appreciation of costs and an awareness of the value of time are imperative. A knowledge of business economics, accounting, financial and contractual relations is of value to the engineer in his work and in handling his own financial affairs.

Effective Expression. Even the best ideas have to be sold. The ability to express one's self through both the written and the spoken word is an attribute of major importance. Getting good ideas is only half of the battle. The engineer must use the language convincingly in conversation and in prepared talks, or through letters, articles, and reports.

Integrity. This quality, together with an appreciation of professional ethics, loyalty to his company, and proper regard for confidential information, are inherent characteristics of a professional man.

Obviously, the foregoing attributes are not minimum requirements for industry. Rather, they are the qualities industry and the colleges are attempting to develop in the young engineer. They are the same qualities each of us is striving to develop in himself.

A SIX-POINT PLAN

Our next step is to prepare a plan which will develop the qualities we have outlined as desirable. Needless to say, we have carved out a man-sized job for ourselves. It becomes immediately apparent that a positive program of action is required. Moreover, we must do some broad-gage thinking or we shall fall short of the mark. I should like to offer a six-point plan for your consideration.

1 *Selection and Recruitment*

The first requisite in building an organization for the long pull is the recruitment of capable people. It is not only important that a company have a flow of new blood into the organization, but it must be the right type. Careful screening of candidates is essential, since an engineering degree is not, in itself, evidence of fitness for a particular company. Errors in selection not only result in the employment of misfits who prove costly in terms of turnover and employee dissatisfaction, but deprive the company of good men who will be needed. Men recruited at the colleges for jobs on the first rung of the professional ladder should be selected for their potential rather than their ability to become immediately productive.

2 *Initial Training*

A well-organized training program not only helps the young engineer make the transition from the college campus to a productive job in industry, but it gives him the specific knowledge he needs to move forward. His formal engineering education has given him an understanding of fundamentals. Industry must provide the industrial "know-how." Through a brief period of orientation, he receives proper introduction to the company, its people, products, and policies. A series of coordinated work assignments and conferences provide firsthand knowledge concerning the company's operations, the avenues of opportunity open to him, and the type of work for which he is best fitted. Periodic counseling during the training period gives assurance that the program is serving the needs of the individual and the company. Normally, the initial training period extends over a period of about a year.

3 *Follow-Up Training*

But initial training is not enough. There is need for continuous training on an informal basis as the young engineer moves along in his career. In the earlier phases, it is important that he be placed with an experienced engineer who has a healthful outlook toward the profession and an understanding of the problems confronting the young engineer. He should have the qualities of a good teacher. A sympathetic approach will do much to bring out the young man's good qualities and strengthen his shortcomings.

As the young engineer gets a "feel" of the work, he should be encouraged to assume responsibility as fast as he can handle it. Job satisfaction is the key to good work, and satisfaction depends, in a large part, on the extent to which the job draws on all the employee's talents. Flexibility in arranging jobs makes possible the use of the individual's abilities at the highest level. Job rotation broadens his knowledge and prepares him for advancement.

4 *Education*

Continued education is an integral part of an effective development plan. Encourage the young engineer to plan his own self-improvement program. It will keep him mentally alert, broaden his background, and provide a foundation for future assignments. Moreover, his educational pursuits give him a sense of personal accomplishment. Encourage him to develop his plan early in his industrial career, for experience has demonstrated that unless he formulates such a plan soon after he leaves college, he is not likely ever to do so. The plan would include informal as well as formal education to extend his technical knowledge and to fill in deficiencies of his undergraduate work.

Management must do more than encourage the employee; it must provide opportunity by working with the local college in offering evening courses or arrange company classes. Three educational areas should be considered:

(*a*) *Engineering Graduate Study* in fundamentals leading to advanced degrees to develop the technical competence of those going into the technical fields of work.

(*b*) *Business Education* in economics, accounting, statistics, finance, and marketing are of value to all industrial people, especially those in sales and the business aspects of the company.

(*c*) *General Education* in such fields as human relations, psychology, history, and speech for personal development.

In recent years a number of companies have arranged extensive evening educational programs on both the graduate and the undergraduate levels, and the number is increasing. These programs, sponsored jointly by certain universities and companies, are making a real contribution. In areas where this form of education has been tried, the programs have the enthusiastic support of faculty, management, and employees.

5 *Professional Activities*

Participation in the engineering societies and civic organizations does much to develop the well-rounded individual we want. Contacts with people with different backgrounds and interests broaden his point of view and bring new ideas into the company. No one company has a corner on all the best methods. Active participation engenders a sense of belonging and promotes professional consciousness. Committee activities promote true teamwork, rather than a mere follow-the-leader attitude. The preparation and presentation of papers builds self-confidence and gives the professional employee recognition in his company and community. Management must set the example by taking a leading part in the activities of the professional societies, such as The American Society of Mechanical Engineers.

6 *Executive Development*

An executive talent search and development program is a must. Under our six-point plan, we do not have to start from scratch in developing executive leadership. The programs outlined in the foregoing paragraphs provide a foundation and bring potential leaders to the attention of top management. Our point 6, therefore, concerns itself with grooming these men on the lower supervisory levels for positions of larger responsibility.

Development at this level is, by necessity, individualized. An engineer normally becomes a specialist. To manage effectively on the higher levels, he must be a "generalist." Through horizontal promotion, special assignments, and advanced training, broad-gage executives are developed. Decentralization of operations and the "divisional type" of organization, common in large companies, contribute to the development of competent executives.

Our basic six-point plan is a flexible one. It is adaptable to companies large or small. I have attempted to prepare a basic design only. The details of the individual programs and the way of operating them must be tailored to fit the needs of the particular company. In large organizations, the plan would be co-ordinated by the training department or a personnel development group. In the smaller companies, all that is needed is top management's support, and a man who is interested in devoting part of his time to such an activity.

Real progress is being made in all six areas discussed. A number of companies have excellent over-all development programs. Other companies do a good job in certain training and educational areas. Too frequently, however, little or no activity is evident. But the idea is taking hold. Engineering societies and professional groups are especially active. One of the most outstanding projects on professional development is that of the Committee on Professional Training of the Engineers' Council for Professional Development. The constructive program which the Committee is developing should bring about the co-operative action of the employer, the college, and the technical societies in the professional development of the young engineer. It deserves our wholehearted support.

MANAGEMENT ATTITUDES

We have not yet discussed the keys to the success of our six-point plan. They will be found in the attitudes and the point of view of management. The best-designed program will be ineffective without top management's support. Moreover, the results obtained will depend on the motives. If management thinks of the plan only in terms of the returns to the company, it will not have the support of the employees. Certainly, a patronizing attitude will not bring the desired results. Realistically, the plan must be based on a philosophy that the results will accrue to the benefit of both the individual and the company. The responsibility for carrying out a personal-improvement plan rests squarely on the individual's shoulders. Management's responsibility is to provide opportunity, to encourage self-development, and to give recognition for demonstrated ability. Such a philosophy provides a favorable climate for growth. A positive plan, boldly conceived and ably administered, will raise the level of professional competence throughout the organization and create a reservoir of future leaders.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Engineering-College Enrollment

APPROXIMATELY 198,000 engineering students were enrolled in the fall of 1949 in 141 schools accredited by the Engineers' Council for Professional Development, according to the annual report on enrollment in engineering colleges published in the February, 1950, issue of *The Journal of Engineering Education*. The report was prepared by Robert C. Story and Henry H. Armsby of the U. S. Office of Education.

Undergraduate students numbered 180,646, while 15,079 were studying for the master's degree. There were 2541 students pursuing work leading to the doctor's degree.

When enrollment in ECPD accredited schools is combined with that of other U. S. engineering schools, the number of undergraduate students is increased to 201,927.

Engineering students constitute about 9 per cent of all college and university students in the United States, as reported by the U. S. Office of Education.

The 141 institutions accredited by the ECPD, together with 39 other U. S. engineering schools, conferred, during the year ending June 30, 1949, a total of 45,200 bachelor's degrees in engineering, 4798 master's and professional degrees, and 417 doctorates. These constitute 12 per cent of all bachelor's degrees conferred by U. S. Colleges and universities, 9.5 per cent of all master's degrees, and 8 per cent of all doctorates, as reported by the U. S. Office of Education.

The distribution of undergraduate enrollment among the four principal curricula for U. S. schools accredited by the ECPD is as follows: mechanical engineering, 42,758; electrical engineering, 40,946; civil engineering, 27,135; and chemical engineering, 17,392. Together, these four curricula enroll 71 per cent of the total undergraduate engineering students. In the American Society for Engineering Education report for the fall of 1948 they enrolled 63 per cent of the undergraduate students in a slightly different group of institutions.

The data used in this report are based on a survey of engineering schools and colleges made in October, 1949, under the joint sponsorship of the U. S. Office of Education and the ASEE.

Replies were received from all institutions accredited by the ECPD, from 39 other U. S. institutions, and from 8 in Canada.

As proposed by the joint ASEE and Office of Education Committee and approved by the ASEE General Council, the tabulations in this report list individually only the ECPD accredited institutions (eligible for active institutional membership in the ASEE), but contain data for the other U. S. institutions as a group and for the Canadian institutions as a group. Detailed data for these two groups of institutions will be made available by the U. S. Office of Education.

The enrollment data for the 180 institutions in the 1949 report are not directly comparable to previous data published annually in the Journal of Engineering Education. However, the ECPD accredited list in the 1949 report is quite similar to the list of schools published in previous reports. This is evident from the fact that of the 146 reporting schools in 1949, 137 are included in the 1949 list of ECPD accredited schools. The changes in listings alone would cause the 1949 undergraduate enrollment in ECPD accredited schools to be approximately 4 per cent less than the enrollment in the 1949 and previous reports. The changes in listings have negligible effect upon graduate enrollment.

The tabular material in the report presents enrollments by class and by sex, and degrees by level and by sex, for each institution accredited in at least one curriculum by the ECPD, and under each heading a single total for the 39 institutions not so accredited. It also presents national totals by class or level and by sex for each curriculum recognized by ECPD.

Power Sources Survey

A SURVEY of power sources, said to be the most comprehensive ever made, is contained in a three-volume study covering both electrical and nonelectrical devices and is now available to the American public, the Office of Technical Services of the U. S. Department of Commerce announced recently.

Prepared by the Armour Research Foundation, Chicago, Ill., for the Signal Corps, the study is concerned with methods of generating electric power, including various prime movers suitable for this purpose.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources, i.e.: (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

The first volume deals with the predominant use of electromagnetic generators for power production and discusses historical and recent trends toward greater output, lighter weight, and smaller size of such devices. The value of thermoelectric generators is also discussed in applications where simplicity, quietness, or the ability to utilize waste heat are important.

Volume II covers electrostatic generators, comparing their high efficiency with disadvantages like noise and radio interference, and concluding that their possibilities warrant further exploration. Other specialized types of electric generators are discussed with the general conclusion that their use is normally limited to such functions as power control rather than power production.

The third volume (Part 2 of the study) covers prime movers. Internal-combustion engines are viewed as the most highly efficient type of unit, with primary drawbacks lying in the fields of noise and limitation on fuels. A novel "barrel engine" is suggested as offering special advantages in respect to size per horsepower.

Among the external-type engines, the closed-cycle piston air engine is given special consideration as a possible noiseless portable engine suitable for any type of solid, liquid, or gaseous fuel.

The three volumes contain critical literature surveys, in which data were gathered from several hundred English and foreign-language periodicals, as well as patents issued in various countries, and specification information secured directly from manufacturers.

More than 150 detailed abstracts of various items are included in the volumes, and methods of power generation are evaluated as to their practicability, fields of special usefulness, types of apparatus, and relative advantages, including the special problem of adaptability to camouflage.

The three volumes, under the general title of "Survey of Power Sources," are available separately as follows: Volume I (of Part I) 254 pages, $15.85 in ozalid form; Volume II (of Part I) 193 pages, $11.30 in ozalid form; Part II (prime movers), 226 pages, $12.50 in ozalid form.

Orders should be addressed to the Armour Research Foundation, Technology Center, Chicago 16, Ill.

The Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C., can supply microfilms of the three volumes (listed in order) as follows: PB 98588, $9 in microfilm; PB 98589, $7 in microfilm; PB 98590, $8 in microfilm.

Tracer Measurements

STUDIES being made by the Massachusetts Institute of Technology show that traces of metal worn from the piston rings in a gasoline engine actually can be detected forming part of the cylinder walls. Only radioactive "tracing" techniques make possible measurements sensitive enough to show these effects. The results may be important to designers of many types of moving metal parts by showing how wear can be reduced.

The basic method is to make the atoms radioactive in one block of material which is to be rubbed against another in a friction test. After the two are rubbed together, radioactive atoms from block number one turn up on the surface of number two, and tests show that they have actually become part of the second block. (See comment by J. T. Burwell, Jr., associate professor of mechanical engineering at M.I.T., on page 425 of the May, 1950, issue of MECHANICAL ENGINEERING.)

It is believed that atom transfer probably takes place in the other direction as well. Thus the chances are that "untagged" normal atoms from block number two end up on number one after such a friction test.

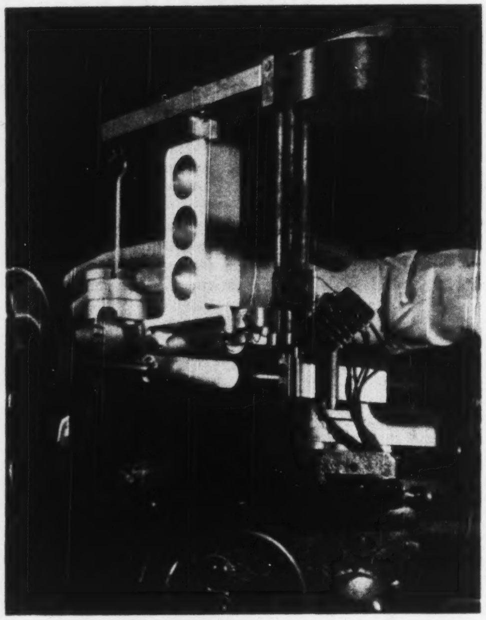


FIG. 1 EQUIPMENT USED TO STUDY FUNDAMENTALS OF FRICTION, WEAR, AND LUBRICATION SHOWS A CYLINDRICAL SPECIMEN TURNING AGAINST A RADIOACTIVE SPECIMEN

Even with good lubricants between the blocks the same transfer effect is observed, though on a much reduced scale. Thus the method might become very useful for evaluating the effectiveness of any lubricant.

The first friction studies were made with two cylindrical specimens, one of which was held stable while another turned against it. After a specimen, made radioactive in a cyclotron, had rubbed against a normal one for a few rotations, there were bands of radioactivity on the latter. The amount could be counted with a Geiger counter. But more accurately, it could be measured by observing the streaks left on a photographic film left wrapped around the cylinder for a week or more.

Proof that the radioactive atoms have become part of the nonradioactive surface is the fact that they cannot be scrubbed off except by honing.

A single-cylinder test engine in the Sloan Automotive Laboratory, fitted with piston rings plated with radioactive chromium, showed metal transfer from ring to cylinder wall during even "the mildest conditions of engine operation." These tests were made immediately after installation of new rings—the "break-in" period where a high rate of wear would be expected.

The chromium-plated rings were so "hot" with radioactivity that they had to be installed in the engine with long-handled tongs and ring compressors. Soon it is hoped to use solid rings of radioactive iron with which it should be possible to study transfer, if any, after the ring-and-cylinder combination is past the high-wear "run-in" period.

A recent application of the same method has been in a study of metal-cutting milling tools made in the M.I.T. metal-cutting laboratory. As it cuts through metal, the engineers found, such a tool is slowly worn away and dulled. But it is also dulled by the metal piling up from the piece being cut, in the same way snow piles up on the blade of a snowplow. Even the best cutting fluid reduced, but did not eliminate this effect.

How accurate is this method of measuring metal transfer in friction? The amount of metal left on one block by rubbing another against it may be as little as one hundred millionth of an ounce. The chromium transferred from piston ring to cylinder wall in the one-cylinder engine was less than three 10-millionths of an inch thick. But in both cases, photographic film gives an accurate picture of the result.

Radioactivity, it is pointed out, is the most powerful tool yet used to study metal transfer as a factor involved in friction. It promises to be increasingly important in helping scientists learn more about the fundamental character and processes of friction.

Engineers and Bankers

BANKERS need the special talents and training of engineers in the banking business, A. J. Gock, chairman of the board of the Bank of America, Los Angeles, Calif., told the American Society of Civil Engineers at its recent spring meeting held in Los Angeles.

He pointed out that science and technology have made such great advances in the past quarter of a century that every industry and nearly every business have problems with technological aspects which bear on successful and profitable operation. Banking is no exception to the rule.

With increasing frequency bankers are encountering scientific and technological problems which few bankers have the necessary background and experience to interpret successfully, Mr. Gock stated. Engineers, on the other hand, have had a specialized type of training which involves the solution of problems. The engineer's training is of the type that produces an analytical mind. He is interested in trends and relationships. It is for these reasons, Mr. Gock believes, that a potential market exists for the services of engineers not alone among bankers but among businessmen in general.

For example, when a banker desires information on some subject, he likes to have it presented to him in the form of a set of figures which he studies to arrive at a conclusion. An engineer will take a similar set of figures, but will work them up in the form of charts or graphs, and from these he will not only reach a solution but in addition will develop information regarding trends and relationships. This habit tends to develop the engineer's powers of analysis to a high degree.

Such ability could be of great help to the banker in analyzing risks on which the bankers must base the terms of loans, Mr. Gock said. In the case of long-term loans, intangible factors assume considerable importance and must be evaluated. Such factors include unforeseen obsolescence of plant and equipment, new developments or techniques, changes in price levels or production costs, shifts in management, changing public tastes, or local conditions. It is in evaluating factors such as these that the engineer could be of service to the banker.

Mr. Gock said that he had in mind engineers who have retained their knowledge of engineering fundamentals but have added to it mature judgment, vision, and a sound knowledge of materials, men, and money. Such engineers are not plentiful.

He urged younger engineers to give thought to the broadening of their studies and reading beyond the narrow scope of their job or specialty into the broader fields of economics, history, finance, management, politics, and people. In this way the engineer will be better able to take advantage of the potential market which exists for his services in banking and business in general.

Hand Torch

A NEW portable hand torch, invented by Louis A. Falligant, president, Pressure Products Corporation, Chicago, Ill., using a new bottled-gas type of fuel, was demonstrated recently in New York, N. Y. It is said to be the first major advance in the torch field in 50 years.

The torch clamps over a disposable gas container about the size of a conventional beer can. The fuel, developed by the Phillips Petroleum Company, boils at a temperature of 39 F and maintains a constant pressure in the lightweight seamless-steel container until all fuel is used. The novel feature of the torch is its ability to light off instantly without pouring, pumping, or priming. It burns with a clean blue flame of 2200 F and maintains its flame at all angles of operation.

The disposable container, developed by the Crown Can Company, is actually a pressure vessel. Each container is individually tested and inspected in compliance with Interstate Commerce Commission regulations. The cans contain 3 cu ft of liquefied gas with a heat equivalent of 8500 Btu—enough fuel to operate the torch from $1^1/_2$ to 4 hr depending on the size of the flame used.

According to Mr. Falligant, exhaustive safety tests have been run on the fuel and container for benefit of state insurance companies and state industrial commissions, during the past two years. In each case the fuel was shown to have superior safety properties. It burns only in the presence of oxygen and its

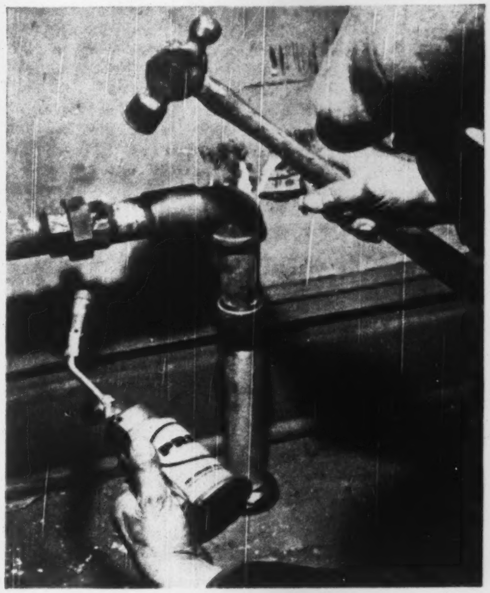


FIG. 2 PORTABLE HAND TORCH SHOWN IN USE BREAKING A TOUGH UNION

pressure and vaporization characteristics (38.6 psia at 100 F) will not permit air to enter the container in quantities to support combustion.

The torch is only the first application for the new fuel. Other tools and appliances in the design stage include weed burners for home gardeners, a camp stove, a solder dip pot, and a camp lantern.

The fuel seems to have only two limitations which are not considered too serious by the developers. Until sufficient demand is created, a container will sell for about $1. Since the fuel will not vaporize at temperatures much below 39 F, appliances will not operate below this temperature.

Turboprops Vs. Turbojets

AERONAUTICAL engineers, until now confined to the use of internal-combustion engines for powering commercial air transports, were given a choice of turbojet or turboprop engines for use in tomorrow's aircraft, at the SAE National Aeronautics Meeting held in New York, N. Y., recently. Both were described as capable of driving the commercial air transports at cruising speeds of 400 mph or better, operating for much longer periods between overhauls, and providing operational advantages said to be undeniable.

R. M. Hazen, director of engineering of the Allison Division of General Motors Corporation, recommended the turboprop power plant as best adapted to airlines operations for the reasons, among others, that the turboprop combination can replace reciprocating engines in present planes, will function with reasonable fuel consumption, and will assure ease of handling and maneuverability at airports without greatly sacrificing speed in the air.

On the other hand, Winnett Boyd, of A. V. Roe Canada, Ltd., advocated the use of the turbojet, pointing out that it provides the speed, comfort, and reliability which the flying public demands, that it alone can give air transports cruising speeds of 500 mph or better, and that this power plant alone is adequate for high-speed, luxurious travel over great distances.

Mr. Boyd admitted that there was a place for the slower airplanes fitted with turboprop power plants and also, with the present reciprocating engines, in the short-haul field, but added that even with its obviously greater fuel consumption, economics favors the turbojet for fast flying over great distances in the early future. He likened turbojet airliners to the streamlined Diesel trains which, introduced as premium-fare passenger carriers utilized for long fast runs, eventually were discovered to incorporate such operating economies and other advantages as to recommend their use in replacing steam equipment for nonpremium, short-distance runs.

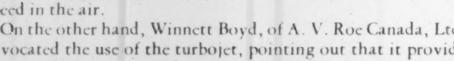


FIG. 3 COMPARATIVE EARNING POWER—TURBOJET VS. MEDIUM-RANGE TURBOPROP

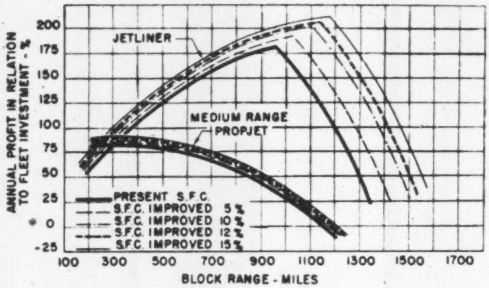


FIG. 4 EFFECT OF IMPROVED SPECIFIC FUEL CONSUMPTION ON EARNING POWER—TURBOJET VS. MEDIUM-RANGE TURBOPROP

Turbojet transports, Mr. Boyd explained, undoubtedly will be the first adopted for premium-fare runs but will soon demonstrate their economy and will subsequently displace their slower turboprop and piston-engined rivals on a large majority of the "bread-and-butter" runs. As in the case of the railroads, this process of replacement may necessitate the premature retiring of existing aircraft, replacing them with turbojets, simply because it is the most economical thing to do. It is difficult to appreciate the reticence of the North American airlines toward turbojets, as the first one that adopts them will force the pace for the others. After they have all taken the "plunge" they will find that the water is more pleasant than they expected; indeed, extremely pleasant to the tune of considerably greater earnings on their investment.

Mr. Boyd predicted that by 1956 turbojet engines will be mechanically simple compared with turboprop and piston types, capable of operating 1000 hr between overhauls, greatly improved in fuel economy, and definitely more reliable than any other type. Already, he said, such an engine, an Orenda, has been operated for 784 hr without major overhaul, during which period it completed several rigorous flight tests, and was stopped only because a member of the test crew accidentally dropped a bolt and a package of razor blades into the intake. He described the result as minor damage to some of the turbine blades, but with the rest of the engine unharmed and capable of prolonged operation.

Mr. Hazen declared that the turboprop power plant best meets the operation requirements of airlines, affording a desirable combination of great power, low weight, and modest fuel consumption. He said that currently available turboprop power plants can be installed in military and commercial aircraft at the cost chiefly of nacelle changes, whereas turbjets still are in the developmental stages and cannot be available for use before at least three years. He cited other turboprop advantages as including better take-off conditions and lower cruise fuel consumption with the most economical fuel costs at least to 500 mph and perhaps more. The turboprop has greater flexibility for commercial uses, he continued, and promises, with further research, to pay greater dividends by way of efficiency and economy.

If turbojet and turboprop power plants are compared on the basis of take-off requirements, such as pounds of power plant weight per pound of take-off thrust at 70 mph, Mr. Hazen explained, turboprop power plants have an advantage of about one third, this being a measure of power plant only. When

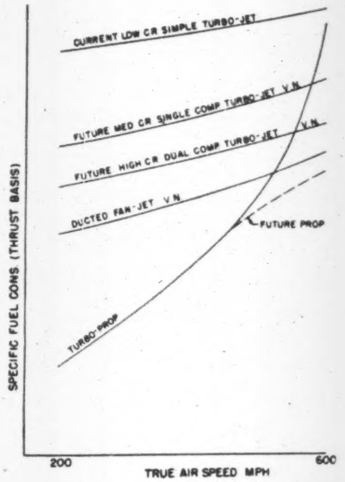


FIG. 5 RELATIVE FUEL CONSUMPTION OF VARIOUS POWER PLANTS

comparison is made on the basis of the requirements of airplane weight to perform a certain task, such as the weight of the plane, engine, and fuel to carry a certain pay load 1000 miles at 35,000 ft altitude and 500 mph, the advantage of the turboprop was indicated to be on the order of two thirds. On a flight of 3500 miles at 35,000 ft and 500 mph, the turboprop was indicated to require only about one quarter as much fuel as the turbojet.

The turboprop engine, Mr. Hazen added, is outstanding in its ability to get an airplane load off the ground and in its specific fuel consumption after it gets in the air. To what maximum cruising speed this advantage will be retained depends largely on the rate of development of propellers, which depends on the funds applied to their continued development.

Ramjet Test Chamber

A NEW supersonic ramjet-engine test chamber which can simulate flight speeds up to 2600 mph and altitude conditions up to 80,000 ft has been developed for the Air Force by the Wright Aeronautical Corporation of Wood-Ridge, N. J. The test chamber, an article in the CADO *Technical Data Digest* reveals, is 12 ft in diam and 96 ft long, and was designed particularly for the development of supersonic ramjet engines. It is part of a multimillion dollar facility at Wood-Ridge capable of testing all types of jet engines, including turboprops and turbojets.

Ramjet engines exceed turbojet efficiency at speeds of more than 1000 mph. The ability of the new test chamber to simulate speeds nearly four times that of sound, and altitudes up to 15 miles, will enable the U.S.A.F. to obtain data on ramjets unobtainable before.

In a typical test a ramjet is mounted on a platform in the center of the 12 × 96-ft stainless-steel chamber. Air supplied by turbine compressors in the adjacent turbine laboratory is directed at supersonic speeds through a "mouth" 20 in. in diam, at the front of the chamber into the air-intake duct of the ramjet engine. The motors which drive the air compressors are capable of producing 15,000 hp, and the compressors can deliver air at the rate of 140 tons per hr.

Pressurized steam at the rate of 150 tons per hr is vented into the chamber's exhaust system to aid in the escape of exhaust gases from the ramjet and to reduce pressure in the chamber, thereby simulating high-altitude conditions.

By varying the incoming air pressure and the outlet steam pressure, it is possible to "starve" or "overfeed" the engine, thus bringing about changes in altitude and speed. The thrust generated by the engine being tested is measured by an electronic thrust computer attached to the engine.

Three cylindrical silencers, each 45 ft high, have been installed at the end of the exhaust line to muffle the roar of exhaust gases and steam jets.

Because of the great heat created by the ramjet engine and the steam exhaust, an elaborate cooling system which jackets the chamber with a layer of circulating water was built as an integral part of the tank. Temperatures of the gases near the exhaust end of the chamber run as high as 4000 F, and this heat causes the test chamber to expand about one inch over its entire length. The test chamber is therefore supported by rollers.

Integrally Stiffened Skin

AN aluminum extruded integrally stiffened skin for aircraft construction and the process by which it is produced was presented at a technical conference held at Phoenix, Ariz., on April 6–7, under sponsorship of Air Materiel Command, Wright Field, Dayton, Ohio, in co-operation with Reynolds Metals Company who developed the product.

The name "integrally stiffened structure," it was explained, is a designation applied to construction in which the skin and skin-stiffening elements are made of one part. This is in contrast with conventional structure which is built up of many fabricated sheet-metal parts held together by a multitude of attachments. One of the principal advantages of extrusion is the ability to produce the most complex cross sections.

It was pointed out that the extruded sections have high physical properties, and because of the excellent detail configuration, they will carry high-compression stresses even with widely spaced supports, thus both weight advantage and simplification of internal structure can be obtained.

Indications are that the new process will enable manufacturers eventually to build military aircraft wings and probably fuselages and floors without internal spar bracings. Whole fuselages whose strength and weight would make them superior and faster than current aircraft designs were foreseen as a probability.

This innovation, it is said, will also eliminate much of the

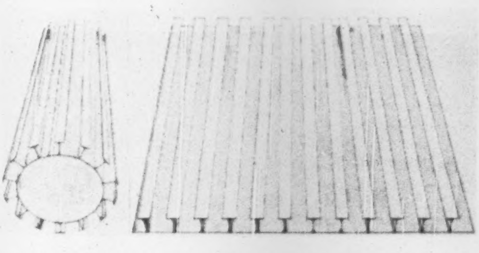


FIG. 6 DIAGRAM SHOWING METHOD OF MAKING INTEGRALLY STIFFENED SKIN

(*Left:* Ribbed sheet is extruded from a hydraulic press in the form of a tube. *Right:* Tube is then slit lengthwise along dotted line and opened up by a series of straightening and stretching operations to produce ribbed sheet.)

riveting necessary in aircraft manufacture and will result in improved mass-production methods and considerable savings in manufacturing costs. It was also reported that there is a possibility that the light metal could be used to reduce weight and save space in constructing other types of transportation equipment such as buses and railroad equipment by using the material as metal walls and flooring. Reynolds Metals Company has been working on the process in its Phoenix plant for more than a year under an experimental contract with the U. S. Air Forces, Air Materiel Command, which is seeking better construction methods for high-speed aircraft.

In the process ribbed sheet is extruded from a hydraulic extrusion press in the form of a tube. This tube is then slit lengthwise and opened up by a series of straightening and stretching operations to produce a ribbed flat sheet. It was decided to concentrate upon a section which has an 8.858-in. ID, a circumscribing circle diameter of 11.86 in., a web thickness of 0.060 in., a flange thickness of 0.100 in., and a skin thickness of 0.070 in. Its developed width is nearly 28 in., and weight per foot 5.784 lb. This section was extruded successfully in 61S, 24S, and 75S alloys, and is considered commercial. It has 14 T-shaped stiffeners.

The first design worked out as an extrusion involved a 4-in-diam tube with a $^1/_8$-in. wall. Most of the development work has consisted in going to thinner walls and larger diameter. At the same time, it was desirable to go from the 61S alloy, easily extruded, to the strongest alloy, 75S (difficult to extrude).

One of the problems is to control wall thickness uniformly. That is one of the reasons the circular shape was selected to extrude because a die for this is symmetrical and the forces developed in extrusion are exerted uniformly.

It is necessary to avoid thick and thin sections as the metal will tend to flow erratically through such a die. Balanced forces in the die help greatly in maintaining uniform wall thickness and thus meeting tolerance limits.

In-Flight Refueling

DETAILS on the new flying-boom in-flight aircraft-refueling system developed by Boeing Airplane Company for the U. S. Air Force have recently been disclosed. In using the new refueling method, the two planes fly in formation and the refueling boom, carried under the tail of the tanker plane, is inserted into the special socket in the nose of the plane being refueled. Fuel is delivered under pressure.

Control of the fueling tube is possible through the use of small vee-shaped control surfaces, known as "ruddevators," which govern movements of the fueling boom. A crew man in the rear turret of the tanker plane operates the ruddevator controls and "flies" the fueling-tube nozzle into the socket on the receiving airplane.

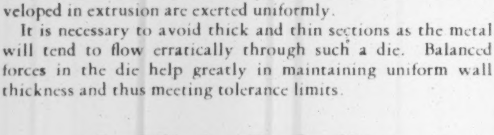


FIG. 7 REFUELING IN FLIGHT BY MEANS OF NEW FLYING BOOM

The flying boom is designed to enable Air Force aircraft to refuel in flight with greater speed and at higher altitudes than previously possible.

Heated anti-icers made by the B. F. Goodrich Company, Akron, Ohio, provide protection for the ruddevators if icing conditions are encountered in flight.

The deicers, made of rubber in which heating wires are embedded, are installed on the control surfaces of the telescoping fueling pipe that is lowered from the tanker plane.

Snorkel

MANY devices have been tried over the years, but it was not until the Germans came up with the Dutch-developed snorkel during World War II that it became possible for the submarine to remain under water for long periods—days or weeks at a time—according to the April, 1950, issue of *The Martin Star*. Oceans can be crossed by a snorkel-equipped submarine, whose interior air will be as fresh as that over the ocean which hides it, the article states.

The snorkel submarine is the first true submersible. Prior to the snorkel, submarines had to surface at frequent intervals to recharge the batteries used while submerged. Diesel engines propelled the submarine along the surface and at the same time charged the batteries. There was always the danger also of battery trouble and the possibility of generation of lethal gases. Too, it might be unsafe for a submarine to surface for battery recharging at the time the operation was required.

Actually a sort of artificial lung, the snorkel is a series of pipelike breathing tubes about as long as a periscope. Air is sucked down into the submarine's hull while it is cruising at periscope depth, submerged, and running on its Diesel engines. As the Diesels do not become exhausted as do batteries, there is theoretically no limit to the length of time a snorkel submarine can remain submerged, as long as there is fuel for the engines.

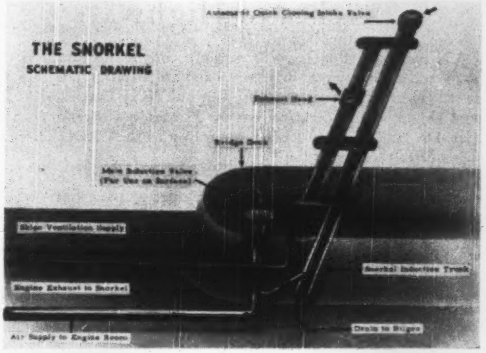
Thus the submarine, always a menace in war and which nearly cost the Allied nations both world conflicts, bids fair to be an even greater problem in the event of a third global conflict. As the top of the breathing tube is barely above the surface of the water, it is almost impossible to detect by radar, so that sound-detection equipment is almost the only way left, although as submarines become increasingly silent in their operation, this method of detection has to undergo constant refinement and increased sensitivity.

Fig. 8 shows the main operating features of the snorkel. The intake head is the only part which projects above water under normal submerged conditions. The intake head contains an automatic valve which closes when a wave washes over it and opens when the head is clear. See also frontispiece, page 452, of this issue.

Part of the air coming in through the valve is taken by duct directly to the Diesel engines for exclusive use of the internal-combustion driver. The balance is for ventilating the interior of the submarine where the men work.

To provide against gases from the engine coming into the working and living quarters, the engine exhaust is connected directly with an exit tube which carries the fumes, together with waste air from the quarters, to an exhaust head for dissipation.

In case of emergency, when it is necessary for the submarine


THE SNORKEL
SCHEMATIC DRAWING
Automatic Quick Closing Intake Valve
Exhaust Head
Bridge Deck
Main Induction Valve (For Use on Surface)
Ships Ventilation Supply
Engine Exhaust to Snorkel
Snorkel Induction Trunk
Air Supply to Engine Room
Drain to Bilges

Official Photograph Departmen of Defense

FIG. 8 SCHEMATIC DRAWING OF A SUBMARINE'S SNORKEL

to descend below periscope and snorkel depth, batteries take over the propulsion of the ship just as they have for years and the snorkel tube is closed off so that no water will enter the ship. Thus even the bare chance of detection by radar is gone.

To detect the snorkel-type submarine is almost like looking for a needle in a haystack. Code-breaking and radio-direction finding may still be used, but they promise to be less effective than during the last World War. Sending of "hunter-killer" groups would be all but futile, as they would have too much sea area to search without even an approximate location of a possible enemy.

While radar and sound are still the principal methods of submarine detection, there are others available, although less effective. One of these is MAD (magnetic airborne detection) mounted in airplanes, helicopters, or blimps. Their usefulness is largely limited to narrow ocean gateways such as the Straits of Gibralter, the English Channel, or the entrance to New York Harbor.

MAD works through the principle of a magnetic needle registering an impulse when the plane passes over the metal hull of a submarine. The sub may be either surfaced or submerged.

A fourth method, the least reliable of them all, requires a good pair of eyes and superwatchfulness. It is visual detection, but the tricks the human eye can play are likely to result in more false alarms than genuine discoveries of submarines.

Underground Metal Corrosion

THE results of early field studies made by the National Bureau of Standards showed that the commonly used ferrous metals—cast iron, wrought iron, and steel—are subject generally to soil corrosion. The Bureau, therefore, in 1932, began a long-term field investigation of the corrosion of metals which either are inherently corrosion-resistant, such as copper and its alloys, lead, and stainless steel, or which had shown exceptional resistance to corrosion in the atmosphere or in natural waters. With the active co-operation of manufacturers, pipeline operators, and local water and gas companies, a sufficient number of weighed specimens of each selected material were buried at the test sites to permit removal of two specimens of each kind after five successively longer periods of exposure ranging from two to fourteen years.

Measurement of the progress of corrosion in the specimens showed that copper and its alloys with silicon, zinc, and nickel are highly resistant, as a group, to corrosion in soils which are very corrosive to ordinary iron and steel. The copper alloys, however, differed rather widely in corrosion resistance, depending on environmental conditions. For example, in soils high in sulphides, copper corroded at an appreciable rate, but low-copper brasses were very resistant. The low-copper brasses showed good resistance to corrosion as manifested by reduction in thickness and by the development of deep pits, but this advantage was offset by their susceptibility to a form of corrosion known as dezincification, which is characterized by the conversion of more or less localized areas into a deposit of spongy copper having little strength. This type of corrosion, it was found, can be prevented by the addition of a fraction of a per cent of arsenic to the alloy.

A number of metals and alloys proved to be corrosion-resistant in the sense that a piping system constructed of any of these materials would give long service underground provided a reasonable allowance were made for reduction in wall thickness by corrosion or penetration by localized attack. Certain steels containing high percentages of chromium and nickel were resistant to corrosion in a more absolute sense, no appreciable weight loss or pitting being detected even after the maximum period of exposure. However, it must be remembered that immunity to corrosion shown by small test specimens does not necessarily mean that a large structure of the same material will last indefinitely. The effect of expanding area on the depth of pitting, which in the case of plain iron and steel is well understood, has not yet been worked out for the high-alloy steels.

The measurements of the corrosion of wrought ferrous specimens indicate that small amounts of chromium, nickel, and molybdenum, which produce high resistance to atmospheric corrosion in the modern high-strength steels, contribute little to their corrosion resistance underground. This difference in behavior is believed to be due to the fact that conditions in soils do not favor the formation of tight adherent rust deposits on which the corrosion resistance of these steels in the atmosphere depends.

Depending on environmental conditions, the progress of corrosion with time was found to range from cessation after a short period to continuance at a rate proportional to the duration of exposure. A high initial rate of corrosion which soon decreases may not shorten the life of a buried structure as much as a low initial rate which shows little or no decrease with time. The one environmental condition which has a predominant influence on pitting and weight loss with time is aeration. Because the initial rate of corrosion of metals in soils is, in general, determined by the accessibility of oxygen to the metal surface, this rate must necessarily be considerably greater in well-aerated soils than in the poorly drained soil deficient in oxygen. However, oxygen in excess of that required for depolarization of hydrogen causes the formation of layers of corrosion products in close contact with the corroding areas, with the result that the corrosion rate is soon substantially diminished, if not actually reduced to zero. On the other hand, in a soil containing no more oxygen than is required to maintain a low rate of depolarization, the products of corrosion diffuse outward into the soil with little or no effect on the corrosion rate. In the Bureau's studies, the corrosion of iron, steel, copper, lead, and zinc has been expressed by a single empirical equation in which one constant is the initial rate of corrosion while the other expresses the progress of corrosion with time.

The change in the rate of corrosion of metals with time is of considerable practical importance. In soils in which the corrosion rate of a metal rapidly diminishes with time, an efficient means of combating corrosion is to provide adequate thickness. If, for example, a section of pipe is exposed to conditions which soon induce a virtual cessation of corrosion rate, the life of the pipe might very well be made infinite simply by doubling the wall thickness. On the other hand, if by doubling the thickness of the metal, only a twofold increase in useful life could be secured, the cost of the extra thickness would not be economically justified; and some other means of combatting corrosion, such as a protective coating, would be indicated.

Casting Process

A NEW process for casting metals that could ultimately bring to the consumer the benefits of reduced cost and improved quality in many items using production-run castings in their construction is being patented by Crown Casting Associates, Boston, Mass.

The benefits claimed to result from this process are as follows: (1) Improved quality in the casting; (2) improved working conditions in the foundries; and (3) reduced cost.

Known as the Croning process, after Johannes Croning, Hamburg, Germany, who developed the process, it employs a Bakelite resin-binder, developed by Bakelite Division, Union Carbide and Carbon Corporation, for producing cores and molds from sand. Although resins have been used for many years in sand-core bonding, the new method is a radical departure in that it does not require long baking and curing and uses relatively small volumes of sand.

The outstanding advantage of the casting produced with the new process is said to be the high-quality precision that is obtained. The casting comes out of the mold with clean sharp edges, true dimensions, and unchilled surfaces that require little or no finishing such as sandblasting or wheel-abrasing. It is stated that the quality and precision of the castings are increased to the point where tolerances of from 0.002 to 0.003 in. per in. can be common practice. Where extremely close tolerances are required, usually only a finish cut is necessary rather than a rough cut followed by a finish cut. In some instances where holes are required in the casting they can be formed in the mold, and subsequent drilling is eliminated.

The procedure used in this process is as follows:

1 The pattern which forms a half mold is first heated in an oven. The pattern must be made of metal because of the high temperatures.

2 Fine sand and pulverized Bakelite resins are thoroughly blended and the dry mixture can be stored for a reasonable time in any quantity that may be required. An excess of this mixture is applied to the hot pattern, and the resin melts, forming a continuous coating over the surfaces. The excess can be removed by inverting the pattern.

3 The pattern with the adhering coating is placed in the oven for 1 to 2 minutes for further hardening. The half mold is easily removed from the pattern by means of knockout pins.

Cores are made in the same manner except that the resin-sand mixture is blown into a hot split core box by means of compressed air. The excess material falls out when the flow of air is stopped. The cores are, therefore, hollow and have the same wall thickness as the molds.

Both cores and molds may be stored indefinitely until needed.

To prepare the mold for casting, two halves are held in a box with the gate vertical while the surrounding space is filled in with steel shot or some other suitable bedding material. The bedding supports the thin mold shell so that it will resist the hydrostatic pressure of the liquid metal. The liquid metal is poured into the mold in the usual manner.

Beaches to Highways

AN inexpensive method of quickly converting sandy beach strips into paved highways for amphibious landings on enemy shores has been developed by the Navy Bureau of Yards and Docks in co-operation with a Princeton University scientist, Dr. Hans F. Winterkorn, according to the CADO *Technical Data Digest* for April 1, 1950.

The method, a chemical process which hardens beach sand within two to three hours, was developed at the request of the Marine Corps to help reduce the heavy loss of life in any future landings on enemy beaches.

Tests show that sand hardened by the process can support the weight of a slow-moving jeep within two hours and a seven-ton truck in three hours. After 24 hr, a truck with a gross load of $13^1/_2$ tons can make repeated runs without affecting the surface, it was found.

Material used in the hardening process is plentiful and costs less than 16 cents per lb.

The new beach-stabilization method is a mixing and densification process performed in a single run over the sand with ordinary roadbuilding equipment. The operation can be completed at a forward speed of 12 fps with the width depending on the capacity of the road equipment used.

Chemically, the process involves low-temperature condensation and polymerization of two liquids through the introduction of a catalytic agent. Because the rate of hardening can be controlled by the catalyst, the hardening times could be reduced by using a different catalytic agent.

The material now used was chosen because it is the most effective with ordinary roadbuilding equipment. But work is proceeding on equipment which will permit faster stabilization.

Electric-Power Exhibit

ALL the apparatus to create electric power, distribute it, and put it to work in a variety of productive ways will be on display in a 10-car industrial-marketing exhibit train recently unveiled by the General Electric Company in Grand Central Terminal, New York. The train, called the "More Power to America Special," will tour the entire United States, visiting approximately 150 key industrial centers during 1950 and 1951.

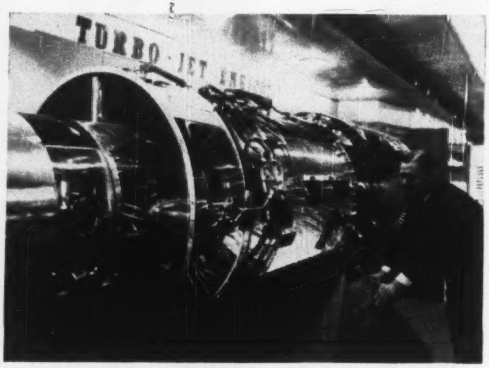


FIG. 9 H. P. BISH OF G-E INSPECTS A FULL-SIZE CUTAWAY MODEL OF THE J-47 TURBOJET ENGINE, ONE OF SEVERAL DISPLAYS IN THE NATIONAL-SECURITY SECTION OF THE TRAIN

Exhibits in the train are grouped in 11 major sections: Power generation, transmission, and distribution; drives and controls; materials handling; welding; industrial heating; renewal parts; industrial lighting; components for industry; measurements; civic improvement; and national security.

Individual exhibits—many of them operating—cover such equipment as turbines, substations, transmission equipment, motors of all sizes and ratings, complex drive systems, industrial and street-lighting fixtures, precise instruments, welding and heating equipment, Diesel-electric switchers, controls, urban transit, and railroad equipment.

Still others relate to atomic power, weather research, guided rockets, aircraft jet engines, ultrasonics, ship-propulsion equipment, fire-control systems, and "snow-making" techniques.

Where size and weight limitations permit, actual equipment is displayed aboard the train. In the case of large steam-turbine generators, power transformers, circuit breakers, and the like, scale models or other representation are used. In many cases the models provide a clearer idea of the apparatus than the actual equipment could. For example, a model of a huge 230-kv impulse breaker has transparent sections and uses varied colored light to demonstrate how 10 million kva of power can be interrupted in less than 0.05 sec.

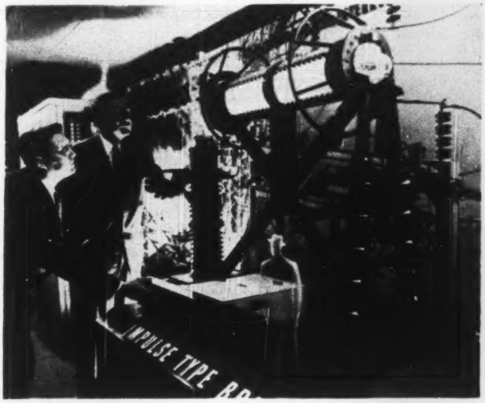


FIG. 10 H. V. ERBEN (*right*) AND J. S. SMITH OF THE GENERAL ELECTRIC COMPANY, OPERATE MODEL OF A HUGE 230-KW IMPULSE BREAKER IN THE POWER-GENERATION SECTION

Another scale model shows how outdoor-lighting installations can be engineered for plant protection, safety, and outdoor recreation. Other scale models include high-voltage test-laboratory facilities, airport lighting, power transformers, and hydroelectric generators.

There are a number of electric-drive systems in operation to demonstrate how various industrial processes can be engineered for high efficiency. These systems show how such variables as thickness, position, speed, tension, and quality can be controlled.

The train's locomotive is a 4500-hp two-unit Diesel-electric built by Alco-GE. It is equipped for operation over any main-line system in the country.

The cars of the train utilize such G-E products as fluorescent and incandescent lighting, water coolers, numerous motors and controls for various functions in the air-conditioning and other operating equipment, Textolite window sills, a new application for that product, and Flamenol cable for all wiring in each of the cars.

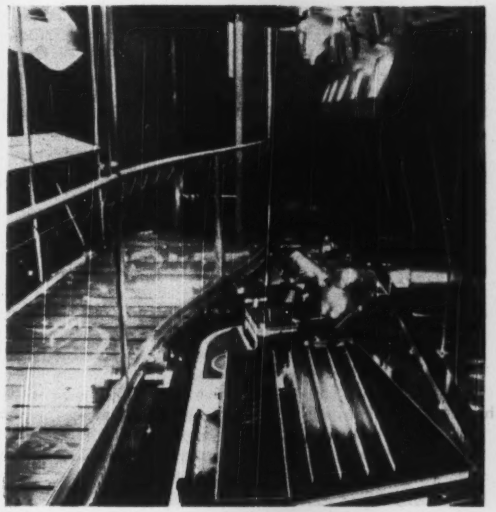


FIG. 11 SCALE MODEL OF A PROPERLY ILLUMINATED FACTORY AREA, ONE OF THE MAJOR DISPLAYS IN THE INDUSTRIAL LIGHTING SECTION OF G-E'S EXHIBIT TRAIN

The 30-kw undercar power plant is an important new General-Electric development used on the train. One of the units is installed as regular equipment on each car to provide electric power for lighting and air conditioning, as well as for operating the exhibits.

The undercar power plant has some important advantages for railroad operation. It makes each car self-sustaining and conserves the power of the locomotive for hauling the train.

The undercar units are trainlined, or connected together, to operate in parallel. If one of the plants is shut down, the others carry the complete load on that car automatically.

The train will not be open to the general public during its tour, according to G-E spokesmen. They explained that the exhibits aboard the train have been designed specifically to interest those who produce electric power and those who put it to work in industry and the community.

British Automobile Show

SIXTY-FIVE leading British automotive manufacturers, including 19 auto makers, participated in the recent British Automobile and Motor Cycle Show at Grand Central palace, New York, N. Y.

Nearly a hundred automobiles, in addition to trucks, buses, trailers, accessories and garage equipment, motorcycles and bicycles, and full lines of Diesel engines, were exhibited at the show which was held under the auspices of the Society of Motor Manufacturers and Traders (Great Britain).

Among the passenger cars displayed were the Allard, Aston-Martin, Austin, Bentley, British Ford, Daimler, Healey, Hillman Minx, Humber, Jaguar, Jowett, Lagonda, M. G. Morris, Riley, Rolls-Royce, Rover, Singer, Standard, Sunbeam-Talbot, and Wolseley.

The luxury autos included the streamlined 132-mph Jaguar

XK.120, claimed to be the fastest stock car ever manufactured, and the world's biggest sedan, the eight-passenger Daimler Straight-8.

The most expensive cars shown were the Rolls-Royce and Daimler. The price list for Rolls begins at $10,000—for the Silver Dawn—and ends in the $20,000 region. Similar figures are quoted by Daimler, Britain's oldest automobile manufacturer, founded in 1896. Both Rolls, who provide a three-year guarantee against chassis defects, and Daimler, who introduced fluid drive as early as 1931, claim to incorporate mechanical innovations never before available in automobiles.

Visitors to the New York show had the opportunity of getting their first glimpse of the new Bristol 401. Built by the British airplane manufacturers, Bristol Aeroplane Company, this 2-liter, 6-cylinder sedan incorporates many new features, including flush-fitting push buttons instead of door handles, a telescopically adjustable steering wheel, armchair seats, and spring-loaded locks operated from the interior for hood, gas-tank filler, and luggage compartment.

The 100-mph Bristol has an aluminum cylinder head which has the dual advantage of saving weight and helping the heat to disperse. Steering is said to be exceptionally light and accurate and the bodywork consists of light-welded tubular structure carrying alloy paneling. It seats 4 to 5 persons.

Also on view to the public for the first time was a new 90-mph three-seater sports car built by the firm of Jowett, makers of the Javelin. Known as the Jupiter, it is described as a high speed car capable of reaching 60 mph in 15 sec. The outstanding feature is a tubular steel chasis which combines lightness with strength. The gear lever is mounted on the steering column and gasoline consumption is 35 miles to the gallon.

The foregoing are only a few of the many British passenger automobiles which were on display at the New York Show.

In addition, the 400-mph Railton Special—said to be the "fastest car on earth"—was on public view for the first time at the show. On Sept. 16, 1947, John Cobb made two runs—north and south—across the Utah salt flats which were timed at 385.6 and 403.1 mph. Thus it was the first car ever officially to register a speed of 400 mph.

The British motorcar industry's biggest postwar surprise car—the gasoline turbine or turbojet—was also unveiled for the American automobile industry and the general public at the Grand Central Palace. It will be at least five years, however, before this revolutionary car becomes a practical proposition for sale to the public and a real competitor of the conventional piston-engine car, according to Sir William Rootes, chairman of the Rootes Group, whose Rover Company, Ltd., developed the car. The gasoline turbine engine is designed to provide clutchless, gearless, and vibrationless motoring. Seven years' work on the model cost the Rover Company more than $280,000.

Calorimeter

A NEW assembly of apparatus called a calorimeter, or "calorie meter," the product of six months' work by two scientists in the Oak Ridge National Laboratory's Chemistry Division, Dr. Glenn H. Jenks and Dr. Fred G. Sweeton, is capable of measuring extremely minute rates of heat formations.

These men had been using two calorimeters utilizing liquid nitrogen, one of which is capable of measuring rates of heat production as low as one-thousandth of a calorie per second—and a calorie is only the amount of heat required to raise one gram of water one degree centigrade. The other—much more sensitive—can measure rates of heat production down to seven-millionths of a calorie per second. Applying heat to water at this same rate, it would take 50 hours to heat one gram of it one degree centigrade.

But these devices were still too crude. Something a little more sensitive was needed. Work was then started on a calorimeter of the same type but one which would use liquid helium as a heat-measuring medium.

Recently, they completed this job. Preliminary tests show their new calorimeter is at least a hundred times as sensitive as the old nitrogen calorimeters. If heat were applied to water at the minimum rate which this equipment can measure, it would take about a year to heat one gram of the water one degree centigrade. One may well ask, why develop such an instrument; and what is its use?

It is well known that the radiations given off by radioactive materials such as radium, uranium, or some other element made artificially radioactive inside an atomic reactor, are a source of heat. In other words, whatever material absorbs these radiations becomes a little bit hotter. Now if we can measure just how much heat is being produced in the absorbing substance, we have a way of measuring exactly how much energy there is in the radiation given off by a particular radioactive material. With this information we can learn much about the way various radioactive materials decay. And therein may lie the means of discovering more of the secrets of the universe and of life.

Boiler-Fueled Diesel

A REPORT in the March 3, 1950, issue of *Engineering* reveals that the ***Auricula***, a single-screw tanker of the Anglo-Saxon Petroleum Company's fleet, berthed at Shellhaven in the Thames Estuary, England, completed about 28,000 nautical miles since last September, during which time her Diesel engine has been run wholly on high-viscosity boiler fuel. The ***Auricula*** completed three years' service on Aug. 17, 1949, burning during this period a normal grade of boiler fuel having a viscosity of between 1200 and 1500 sec Redwood 1 at 100 F, but since September she has been running on Grade C boiler fuel (Shell standard marine fuel F 520), which has an average viscosity of between about 3000 and 3100 sec.

In so far as the performance and handling characteristics of the engine are concerned, there has been no deterioration while using the heavier fuel. As with the fuel of 1200 to 1500 sec viscosity, the characteristic Diesel knock is eliminated due to the flattening of the peak of the combustion curve. The fuel consumption is about the same, 0.301 lb per ihp-hr. Over a period of 100 days' steaming, the average consumption for all purposes was 14.9 tons a day, made up of 12.99 tons for the main engine, and 1.91 tons for auxiliary purposes. Other average figures were: speed, 11.75 knots; mean indicated pressure, 125 psi; and indicated horsepower, 4037.5. The engine—a Hawthorn-Werkspoor four-stroke type—is rated at 4000 ihp, but it was run at the slightly higher figure so as to assure observers that the engine was not "nursed." An appreciable number of hours running were at very slow speeds, but the engine was responsive and handled well.

The fuel oil is heated to 180 F and passed through a purifier and clarifier which are run for about 12 hr a day to supply the engine with sufficient clean fuel. The purifier removes about 2 lb of solid matter from 12 tons of fuel, and the clarifier about 1 lb of solid matter. The fuel of the higher viscosity is supplied to the injector valves, through lagged pipes, at a temperature of 190 F. The injector nozzles now being used each have eight 0.75-mm holes, whereas with oil of 1200 to 1500 sec viscosity they had eight 0.85-mm holes. Nevertheless, there is no lower limit of viscosity—the engine will run on any boiler fuel that is available. The injection valves are normally removed every 1000 hr for cleaning; it has been the practice to clean and polish (not reseat) the exhaust valves every 3000 hr, but one exhaust valve in the engine has already run for 5000 hr and is considered good for another 5000 hr without attention. The average piston and liner wear per 1000 hr is 0.1 mm for the liner and 0.3 mm for the piston.

The *Auricula* has now been running for $3^{1}/_{2}$ years on boiler fuel and the saving in fuel costs during that period is estimated at 21,000 £. From the operating point of view, it is also advantageous to be able to accept any available boiler fuel since fluctuations in supply and demand throughout the world often cause difficulties in obtaining Diesel oil when and where it is wanted. It is not necessary to modify the engine for burning boiler fuel, except, perhaps, that the injector nozzles may need changing. The essential equipment comprises a purifier, a clarifier, and steam-heating apparatus. In the case of the Anglo-Saxon Company's tankers, the conversion takes about three weeks and is being carried out on their vessels whenever they are available for that length of time. Further experiments are being conducted with boiler fuel of even higher viscosities using a single-cylinder Werkspoor unit. The results will be of academic rather than immediate practical interest, since fuels of this type are not marketed for marine use.

Atomic Energy

Nonferromagnetic Synchrotron

SUCCESSFUL operation in its first phase of a new type of atom smasher, which is ultimately expected to produce x rays of 300,000,000 volts, has been announced by Dr. C. G. Suits, vice-president and director of research for the General Electric Company.

The new machine is known as a nonferromagnetic synchrotron and is being built under the joint sponsorship of the Office of Naval Research and the G-E Research Laboratory. It has been operated thus far up to about a million volts and probably it will be in operation at much higher energies before the end of the year, Dr. Suits stated. It will be used to study the effects of high-energy radiation, particularly in nuclear research.

It was explained that the new particle accelerator, or atom smasher, is of a design that eliminates the huge iron-core electromagnet commonly used in such devices. The requisite powerful magnetic fields are produced solely by specially designed coils of wire. These carry heavy currents and are contained in a steel tank from which air has been exhausted.

In the new synchrotron there is a cylindrical steel tank 26 in. high and $6^{1}/_{2}$ ft in diam with one-inch-thick walls. Inside there are a group of coils for obtaining initial betatron acceleration and subsequent synchrotron operation.

There is no separate doughnut, as the entire tank is evacuated and the electrons move in the space between the inner and outer coils. During first operation the vacuum was about a hundred millionth of an atmosphere. This allows enough gas molecules to remain to cause appreciable scattering of the electrons, though it does not prevent operation. As the vacuum is improved, to a billionth of an atmosphere or better, the scattering may be decreased accordingly.

Electron Accelerator

A quarter-scale pilot model of what is expected to be the world's most powerful machine for accelerating protons will be converted into the world's strongest electron accelerator under the terms of a research agreement involving the California Institute of Technology, the Radiation Laboratory of the University of California, and the U. S. Atomic Energy Commission.

The quarter-scale model of the proton machine, whose full-scale counterpart will be called the bevatron, was designed, built, and successfully operated by scientists at the Radiation Laboratory, Berkeley. It was built to test new design principles for the full-scale bevatron which is now under construction. The large machine will operate at energies of more than a billion electron-volts (Bev) with probable maximum energy of 5 to 7 billion electron volts.

The pilot model has been dismantled and will be rebuilt at C.I.T., Pasadena, to provide one billion-volt electrons and x rays for nuclear-physics studies, particularly in the field of meson physics.

The full-scale bevatron will produce protons having energies from 2 to 3 times greater than any other being designed.

This working model was designed and built in a period of 10 months. The information obtained from its operation is expected to save the cost of the model out of the final construction costs of the big machine.

According to present plans, as few changes as possible will be made in the Berkeley model in order to adapt it to the C.I.T. requirements. The speeding electrons will travel around a race-track-shaped path having a radius of 11.5 ft. The accelerating impulse will be provided by a radio-frequency system and the negatively charged electrons will be kept on the course by means of large electromagnets.

At top speed the electrons will be moving at velocities only one ten-millionth of one per cent less than the speed of light, the theoretical but unattainable top velocity for any material particle.

New Research Project

The U. S. Atomic Energy Commission has announced that a new classified research project is being undertaken in the San Francisco Bay area. The project involves the construction of a particle accelerator which will be used to pursue a classified research program for the AEC. The project is expected to cost about $7,000,000.

The program will be undertaken by the California Research and Development Company in co-operation with the Radiation Laboratory of the University of California. The California Research and Development Corporation is a subsidiary of the California Research Corporation which is owned by the Standard Oil Company of California.

The new project will be undertaken at the Livermore Naval Air Station through the co-operation of the Navy Department, which has agreed to work with the Commission in obtaining a transfer of the property. It is expected that the preparation of the Naval Air Station site for the new project will involve the modification of some of the existing buildings as well as some new construction.

Correction—Helicopters

IN the article on "Helicopters," which appeared in this section of the May, 1950, issue of MECHANICAL ENGINEERING, pages 409 to 411, the captions for Figs. 6 and 7 on page 410 were inadvertently reversed. Actually, Fig. 6 shows the McDonnell side-by-side rotor helicopter, while Fig. 7 is a photograph of the Bendix coaxial rotor helicopter.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Fly-Ash Collection

Fly-Ash Collecting Equipment for Small Boiler Installations, by William L. Prout, The Green-Fuel Economizer Company, Inc., Beacon, N. Y. 1950 ASME Spring Meeting paper No. **50—S-33** (mimeographed).

SOME sort of collecting equipment should be provided on all spreader-stoker installations, and on underfeed stokers operating at firing rates above 25 to 30 lb per sq ft per hr.

Low-draft-loss collectors will meet existing ordinances on practically any underfeed-stoker installation. With spreader-stoker firing, some existing ordinances permit the use of low-draft-loss collectors on any installation. Others limit their application to the best-designed and best-operated plants.

If no ordinance exists, high-draft-loss collectors should be used if the dust loading entering the collector exceeds 2.0 grams per cu ft. With lower dust loadings, low-draft-loss collectors will generally prevent a dust nuisance.

If a low-draft-loss collector will not permit the plant to operate on natural draft, a high-draft-loss collector is preferred.

With reinjection two-stage collection is recommended, with reinjection from the first stage only.

In small stoker-fired plants coarse particles, or cinders, are more of a nuisance than fine particles. It is recommended that this be considered in drafting future smoke ordinances.

Designers of small boiler plants are handicapped by lack of information on carry-over from stoker-fired boilers. It is recommended that stoker manufacturers release more such data with various stoker, boiler, and fuel combinations.

Fly-Ash Collection for Small Plants, by A. A. Petersen, Prat-Daniel Corporation, East Port Chester, Conn. 1950 ASME Spring Meeting paper No. **50—S-31** (mimeographed).

THE purpose of this paper is to alert and acquaint small plant owners and management, who burn coal, with fly-ash problems developing due to legislation of more stringent dust codes. The trend indicates, in many cases, that previously accepted methods of controlling fly-ash emission may no longer prove adequate. To meet this problem, a review of various types of dust collectors with the advantages and disadvantages of each relative to dust ordinances is discussed.

The various types of dust collectors available and now on the market are settling chambers, impingement or baffle collectors, electrostatic collectors, and centrifugal collectors such as the large-diameter cyclone, fan collector, and tubular collector.

The settling chamber consists of a hopper, sometimes in a horizontal sector run of duct, but in most cases located at an abrupt turn in the duct to obtain the most effective use of gravity and momentum forces. It is simple, cheap, and requires no maintenance other than periodic ash removal. Its only disadvantage is that in many instances it will not remove sufficient dust to comply with the newer dust codes.

The impingement, or baffle, or low-draft-loss dust collector will separate out a greater percentage of the dust than will a settling chamber and will operate on natural draft, incurring no additional expenditure for an induced-draft fan. Application of gravity and momentum forces to a dust particle is developed by multiple spirals, Venturi elements, and water-film cover plates. Under many conditions, however, this collector will not comply with dust-code limits.

In the early days of the industry, large-diameter cyclone collectors served a definite need as the fly ash emitted was relatively coarse by present standards, which made it possible to maintain a reasonably high degree of collection efficiency. The disadvantage of this design was space, weight, erosion, and the need for an induced-draft fan to overcome the resistance of the collector.

This led to the development of a fan collector which serves the dual purpose of an induced-draft fan and a dust collector. The concentrated dust is recirculated through a cyclone centrifugal collector. Fan collectors are reasonably efficient on dust solids coarser than 43 microns (325 mesh screen) but do not always meet present-day efficiency requirements of fine dust (20–43 microns)

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which has become necessary to meet present-day codes. Further, they require a certain amount of fan maintenance due to erosion and, as a general rule, require greater fan power than a dust collector and efficient induced-draft fan.

Development of the so-called multicyclone dust collector, using smaller cyclones (2 to 5 ft diam) than had been previous practice, made it possible to apply centrifugal forces over a larger boiler range and obtain better flexibility to meet space requirements. Further improvement in dust-collection efficiency was accomplished by incorporating individual dampers in each cyclone arm which were actuated by a common control.

The multicyclone dust collector was and is one of the most efficient machines yet devised for precipitating fly ash. From a standpoint of dust-collection efficiency it will reduce dust emission to the limits prescribed by present-day dust codes. However, excessive space and weight requirements and inherent erosion have limited the full expansion of this development.

The paper concludes that owners and management must realize that an anti-atmospheric pollution crusade is under way and gaining momentum. Since code restrictions do vary it would be advisable to follow closely local public thinking to anticipate and plan proper measures and equipment to maintain a "good-neighbor policy" by proper preparation to meet new dust codes.

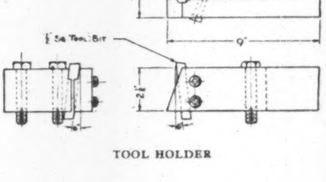
Cutting Fluids—Metal Cutting

Experience With Machinability Repeat-Ability, by E. J. R. Hudec, Jun. ASME, Case Institute of Technology, Cleveland, Ohio. 1950 ASME Spring Meeting paper No. **50—S-2** (in type; to be published in Trans. ASME).

THE experimental work undertaken in the present study was a lathe-turning operation in which the effect of various kinds of cutting fluids on tool life was observed. The method of controlled experiment was used in which the factors involved were held constant while one was varied (in this case the cutting fluid), so that its effect upon the process could be observed.

To establish tool-life values that would be considered reliable, it was desired to check each value by making several repeat runs. With a close agreement between repeat runs, it was felt a reliable tool-life value was obtained. A difficulty encountered, however, was that a large variation occurred between repeat runs (as much as 145 per cent when based on the average), even after great care was taken to make the repeat cutting conditions as nearly identical as possible.

The procedure described relates many experiences that had to be learned the "hard way," and the discussion suggests a means by which it is felt machinability repeat-ability can be obtained.



TOOL HOLDER

It was found that hitherto assumed "constant" factors, such as work material, which are involved in a machinability test, are actually variables over a certain range. In order to repeat machinability test data accurately, extremely accurate measurements are required of all the variable factors involved, to know the exact conditions of each particular test. Through careful study of the effect of each factor on the test results, correction factors may then be applied to individual test results to reduce them to some basic test condition. By this means, machinability repeat-ability may be obtained.

A Study of Heat Developed in Cylindrical Grinding, by R. E. McKee, University of Michigan, Ann Arbor, Mich., R. S. Moore, Quaker Chemical Products Corporation, Conshohocken, Pa., and O. W. Boston, Fellow ASME, University of Michigan. 1950 ASME Spring Meeting paper No. **50—S-11** (in type; to be published in Trans. ASME).

THIS paper, the fourth in a series on cylindrical grinding, presents some of the results of an investigation of the grinding process with particular reference to the influence of the grain size of a grinding wheel and type of grinding compound used on certain criteria, such as volume of metal removed per unit of wheel wear, unit net horsepower, surface finish, grinding rating, temperature increase in the workpiece surface, temperature increase in the grinding compound, and possible injury to the structure of the metal.

The machine used in the investigation was a standard Cincinnati No. 2 cylindrical grinder.

Some of the findings were as follows:

The highest values of "volume ratio" were obtained with type B, a water emulsifiable, high molecular weight, hydrocarbon mixture of low detergency.

The lowest values of "unit net horsepower" were obtained with the type B compound and the type D oil, consisting of a mineral oil mixed with a sulphurized, fatty base.

The most satisfactory "surface finishes" were obtained with the type D oil, when used with the coarse-grain wheels.

The highest "grinding ratings" were obtained with types B compound and D oil when used with an 80-J grinding wheel.

Temperature increases measured on the surfaces of the work specimens are approximately inversely proportional to the thermal conductivities of plain mineral oil and water.

Only two of the five cutting fluids (those of high detergency) show any effect of temper as a result of grinding with an 80-J wheel. These same fluids give the lowest values of grinding rating obtained with this wheel.

Machining of Heated Metals, by E. T. Armstrong, Jun. ASME, A. S. Cosler, Jr., and E. F. Katz, Battelle Memorial Institute, Columbus, Ohio. 1950 ASME Spring Meeting paper No. **50—S-5** (in type; to be published in Trans. ASME).

STUDIES are reported of the machinability of several materials at elevated temperatures. It was found that tool life, cutting austenitic stainless steel, was increased twofold by heating to 400 F. High-temperature alloys, including vitallium, machined freely at temperatures from 700 F to 2000 F. Long curling chips and a smooth, cleanly cut surface were produced in hot-machining. The same materials cut at room temperature developed a glazed uneven surface and the chips were powdery. Austenitic manganese steel machined easily at 1200 F, as did fully hardened high-speed steel. An arc-heating method was developed which permitted continuous heating while machining without heating the work throughout.

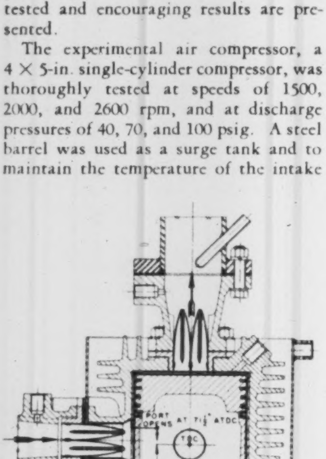
Through the use of this method, surprising improvement in machinability may be achieved. Many materials which are unmachinable by usual methods have been found to machine with ease at elevated temperatures.

Gas-Turbine Power

Pulsating Air Intake for Free-Piston Gasifiers and Other Reciprocators, by E. C. Magdeburger, Bureau of Ships, Navy Department, Washington, D. C. 1950 ASME Spring Meeting paper No. **50—S-20** (mimeographed).

THE problem of induction of atmospheric air into a high-speed reciprocating cylinder is discussed and past efforts to secure greater efficiency are reviewed. An effective solution is presented by a pulsating air intake column tuned to develop three standing half-waves during the period it is isolated from the cylinder and one half-wave with cylinder content added. Piston-controlled ports opening at the region of maximum piston velocity with automatic valves to close with reversal of air flow accurately time the events. Results of tests on a small air compressor are given demonstrating substantial improvement in volumetric efficiency of the compressor and its output. The effect of supercharging on pulsating air intake column was also tested and encouraging results are presented.

The experimental air compressor, a 4 × 5-in. single-cylinder compressor, was thoroughly tested at speeds of 1500, 2000, and 2600 rpm, and at discharge pressures of 40, 70, and 100 psig. A steel barrel was used as a surge tank and to maintain the temperature of the intake air. The discharge pipe from the center was led to a large receiver and standard ASME nozzles were used for measuring air flow.



SECTION THROUGH COMPRESSOR CYLINDER

During the actual tests a constant inlet-air temperature of 100 F was maintained throughout. Three liners were used with different port location and timing of intake and three different intake pipes, one for each speed 1500, 2000, and 2600 rpm. The air flow was measured by standard nozzles according to ASME Power Test Code Specifications. The evaluation of the test data has been made on the basis of measured volumetric efficiency and the ratio of measured volumetric efficiency to theoretically possible volumetric efficiency.

The effectiveness of the pulsating air column as a superior means for charging a compressor cylinder is demonstrated. Optimum results have been obtained when the mechanically controlled vacuum in the cylinder served as excitation for the pulsating air system consisting of cylinder and intake pipe and produced one half-wave, while the intake pipe alone would generate three standing half-waves of higher natural frequency per cycle. Resonance in a pulsating air system of variable capacity was thus produced with the resultant compression wave of maximum pressure amplitude in the compressor cylinder at the end of suction stroke. The automatic intake valves closed when air flow into the cylinder stopped, thereby trapping the compression wave in the cylinder and supercharging it. A redesigned cylinder is required to modify an existing compressor.

Test Experiences With the Annapolis 3500-Hp Experimental Gas-Turbine Plant, by A. C. Skortz and F. R. Gessner, Jr., U. S. Naval Engineering Experiment Station, Annapolis, Md. 1950 ASME Spring Meeting paper No. **50—S-12** (mimeographed).

TEST results and experiences gained from the operation of a parallel-flow gas-turbine plant are presented. Data procured cover an operational period of 3200 hr including extended operation at 1500 F turbine-inlet temperature. Selected graphs and curves are included to show over-all and component performances. Also included are metal temperatures of internal stationary parts during operation at 1300 F, both with and without cooling air.

The unit was first fired on Dec. 7, 1944, and has been in operation some 3200 hr, during which time it has been started 357 times. During this period the plant has been unavailable for operation 72 per cent of the time. Of this down time, 43 per cent has been for adjustments and scheduled inspections, and 57 per cent has been due to the repair of casualties in the turbines (17 months' total time), combustion chamber (1 month), and instrumentation, notably the dynamometer (5 months). This extended period was due to the wartime and postwar difficulties in the procurement of materials.

The impulse blading of the compressor and power turbine, manufactured of Timken Metal (16-25-6), have been subjected to hot gases for 3219 and 2386 hr, respectively. The present reaction blading, composed of 19-9-W-Mo, replaced the earlier Timken material and has been exposed to hot gases for a total of 1819 hr in the compressor turbine and 1201 hr in the power turbine. The history includes operations to January, 1950. During the operating period approximately 500,000 gal of Diesel fuel have been burned, and about 7 billion cu ft of air compressed.

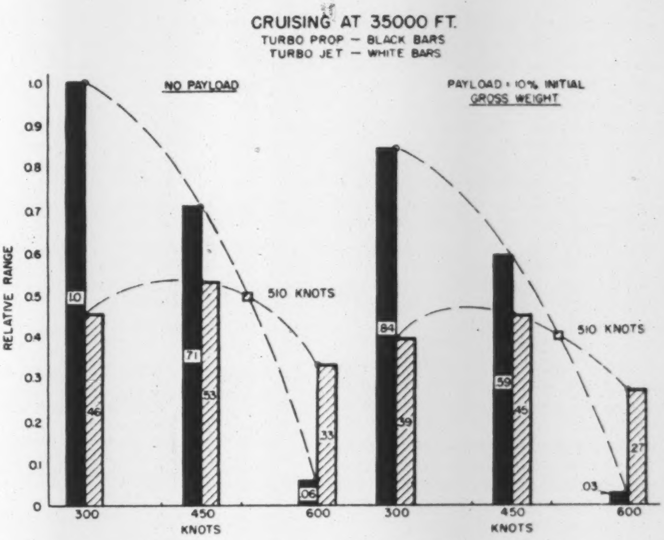
The Prospects of Gas Turbines in Naval Applications, by Comdr. R. T. Simpson, U. S. N., Norfolk Naval Shipyard, Portsmouth, Va., and Comdr. W. T. Sawyer, U. S. N., Bureau of Ships, U. S. Navy, Washington, D. C. 1950 ASME Spring Meeting paper No. **50—S-8** (mimeographed; to be published in MECHANICAL ENGINEERING).

THE history of gas-turbine activity within the Bureau of Ships is reviewed and current work described to the extent commensurate with military security. Requirements which must be met by a prime mover for naval-propulsive service are delineated. The importance of satisfactory turbine cooling is emphasized, and liquid cooling indicated as the optimum method for naval units. Future prospects of the gas turbine are outlined in general terms and a specific arrangement for ship propulsion is described which is considered suitable for immediate application. The arrangement comprises a combination of gas and steam-turbine machinery. Other gas-turbine applications indicated are motive power for emergency equipment with a short operating life, and peak-load power for boats and vehicles, where the requirement of lightweight subordinates all others, save reliability. Applications exist where fuels with the volatility of gasoline are not acceptable and where at the same time powers are sufficiently high or weight limitations sufficiently low to preclude the Diesel.

For example, currently under development for the Bureau of Ships is a 400-hp gas turbine for emergency generator drive with a weight of 600 lb and designed life of 5000 hr (including 500 hr at full power). This prime mover supplants a Diesel engine weighing 8900 lb, thereby saving 8300 lb (93 per cent of original weight) at no sacrifice, since fuel economy in this application is unimportant.

A gas-turbine prime mover for a portable fire pump shows promise of achieving a specific weight of 1.2 lb per hp for a 50-hp output, as compared with 3.7 lb per hp for its gasoline-piston-engine predecessor. It has the added advantage of burning a nonvolatile, nonexplosive fuel, which is, for fire-fighting equipment, definitely desirable.

The objectives of a long-range program are defined, and increased importance is predicted for the closed cycle.



RELATIVE RANGE VERSUS CRUISING SPEED OF TURBOJET AND TURBOPROP TYPES OF AIRCRAFT

The Application of Gas-Turbine Engines to Naval Aircraft, by C. C. Sorgen, Bureau of Aeronautics, Department of the Navy, Washington, D. C. 1950 ASME Spring Meeting paper No. **50—S-25** (mimeographed).

IN the majority of projected Naval combat piloted-aircraft types, it is a foregone conclusion that the gas-turbine-type power plant will be used. In some cases, however, the question arises as to whether to use the gas turbine in the form of the turboprop or turbojet.

The factors affecting a choice from an airplane-performance standpoint are reviewed through a comparison of the specific or relative performance characteristics of the two types of power plant. Secondary factors which affect a final decision, such as relative cost of development, production, and maintenance are also compared in a general way.

On the basis of high-speed performance alone, the turbojet is unquestionably superior to the turboprop. Furthermore, the development, production, and maintenance of the turboprop will be more difficult, expensive, and time-consuming.

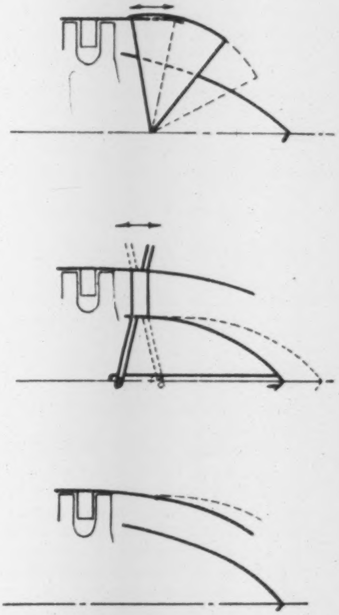
However, the stringent restrictions imposed on the design of naval carrier-based aircraft are a serious obstacle to the use of turbojets for certain tactical types, such as long-range heavy-attack or escort-fighter aircraft. The application of the turboprop to these types, with its particular advantages, gives promise of overcoming these handicaps to the extent of providing stiff competition to land-based turbojet aircraft.

The turboprop aircraft, if it can be developed and exploited to full advantage, will be an impressive weapon well worth the effort put into it. On the other hand, only the turbojet can fulfill certain tactical aircraft requirements. It is considered essential, therefore, to prosecute the development and application of both versions of the gas-turbine engine to meet conceivable requirements of the national defense.

Improving Turbojet Performance by the Use of a Variable-Area Exhaust Nozzle, by O. E. Rodgers, Westinghouse Electric Corporation, Lester Branch P. O., Philadelphia, Pa. 1950 ASME Spring Meeting paper No. **50—S-22** (mimeographed).

THE turbojet engine, as a power plant for military aircraft, has a well-accepted place in the aircraft picture at the present time. There are several turbojet engines in wide use which have satisfactory performance and have achieved a reasonable measure of reliability. These turbojets are all alike in that the simplest possible number and arrangement of components are used. Now that a reasonable reliability has been achieved with this simplest turbojet in service operation, it is timely to consider ways in which the performance of turbojet engines can be improved by changes, refinements, or additions to this simple engine. The pressure to improve performance is great. The need for increasing maximum thrust possible out of a turbojet is always present and the desire to improve the efficiency of turbojet engines is well known.

In this paper, discussion centers on turbojet engines of the general type now in service use. The basic components of such a turbojet engine are an axial-flow compressor of as high a compression ratio as appears feasible in a single cylinder, a combustion chamber, and a turbine of high-efficiency characteristics. These



POSSIBLE VARIABLE-AREA EXHAUST NOZZLE MECHANISMS present turbojet engines all employ a fixed-area exhaust nozzle. The limiting characteristics of these basic components are described and several possible methods of improving the maximum output and efficiency of this type of turbojet engine are analyzed.

It is concluded that the best practicable addition to a simple turbojet is a variable-area exhaust nozzle with a control system suited for the particular airplane application.

A variable-area exhaust nozzle permits changing the proportioning of pressure drop between turbine and exhaust elements. When the turbine pressure ratio is reduced, the control system, in order to maintain engine speed, signals for a higher turbine-inlet temperature so that the turbine power delivered will balance the compressor power required. This higher turbine-inlet temperature increases the volume of the gases which pass through the turbine and thus effectively decreases the turbine flow area. The advantages of this scheme compared with those previously considered are obvious. The moving parts operate, not at the turbine-inlet temperature, but at a temperature lower than this value by the temperature drop in the turbine. A variable-area nozzle can be of several types, but in any case there are no more than two or three movable parts and the mechanical complexity of the system is small. The efficiency of a well-designed variable-area exhaust nozzle can be practically equal to that of the fixed-area nozzle.

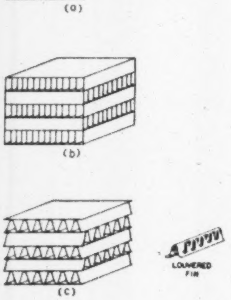
Heat Transfer

Optimum Tube Size for Shell-and-Tube-Type Heat Exchangers, by F. D. Cardwell, Mem. ASME, Chemical Construction Corporation, New York, N. Y. 1950 ASME Spring Meeting paper No. **50—S-6** (in type; to be published in Trans. ASME).

THE total annual cost for a shell-and-tube-type heat exchanger, which is the sum of the annual power cost plus the fixed charges or annual amortization of the initial cost of the equipment, is found to vary sharply with small changes in tube size when the heat-transfer rate is held constant. Equations are developed reducing the number of assumptions to length of tubes and diameter of tubes for fixed design conditions, such as total flow rates in shell and tube and required heat-transfer rate. For a selected length as a parameter, then, the total annual cost can be calculated for each tube diameter. The optimum tube diameter is determined from a graph of these corresponding values which has a well-defined minimum value for the total annual cost. A family of these curves, each having a different length as the parameter, will each have a minimum. These minimal values will all be nearly equal. Another family of curves with standard tube diameter as the parameter will each have a minimum giving the optimum length for each diameter. Therefore only one convenient parameter need be selected from which the optimum combination can be determined from a curve. Since the required heat-transfer surface area is now known, the number of tubes for this combination follows automatically.

Loss Coefficients for Abrupt Changes in Flow Cross Section With Low Reynolds Number Flow in Single and Multiple-Tube Systems, by W. M. Kays, Jun. ASME, Stanford University, Stanford, Calif. 1950 ASME Spring Meeting paper No. **50—S-7** (in type; to be published in Trans. ASME).

IN testing for the flow-friction characteristics of compact heat-exchanger surfaces concurrent with heat-transfer tests, more precise data on the flow contraction and expansion-loss coefficients are required than are presently available in the literature. This paper presents a theory for evaluating these coefficients for both single and multiple-tube systems for various contraction and expansion geometries. The analysis takes into account the contraction and expansion area ratio and the velocity distribution. Results of experiment for the Reynolds number range 500—20,000 are presented which compare well with the analysis. This paper was originally presented at the June, 1949, meeting of the Heat Transfer and Fluid Mechanics Institute, and included only experimental data on multiple-tube systems. Since that time experiments have been performed on single-tube systems and these later results are presented here.



THREE EXAMPLES OF MULTIPLE-TUBE HEAT-EXCHANGER SYSTEMS

Local Coefficients of Heat Transfer for Straight Fins, by M. L. Ghai and Max Jakob, Illinois Institute of Technology, Chicago, Ill. 1950 ASME Spring Meeting paper No. **50—S-18** (mimeographed).

THE present investigation was carried out to determine the variation of local coefficients of heat transfer, hitherto unknown, between root and tip of straight fins, using air as cooling fluid. The determination of these coefficients was primarily based upon a theoretical equation of finite temperature differences in a fin and the measurement of many local surface temperatures. Such problems were faced as how to install fifty thermocouples in a fin element 2 in. × 4 in., how to run each thermocouple for 2 to 3 in. in an approximately isothermal zone, and how to guide all thermocouple wires so that the air flow over the fins was not disturbed. To overcome these difficulties, the construction of experimental fins of an unusual design was necessary. Fin spacing was varied from $^1/_8$ in. to $^3/_4$ in., and air velocity was varied from 21 fps to 77 fps. The results were correlated in terms of local Reynolds and Nusselt numbers. The local coefficients found in this investigation can be used to determine precisely the heat dissipated by a fin. But, since this requires a very complicated procedure, a simpler approximate method based on a mean coefficient of heat transfer has also been developed.

Experimental Evaluation of Human Shape Factors With Respect to Floor Areas, by F. W. Hutchinson, University of California, Berkeley, Calif. 1950 ASME Spring Meeting paper No. **50—S-4** (in type; to be published in Trans. ASME).

RESULTS are presented for the shape factor of an average standing person with respect to energy in the form of heat received from a floor area.

The subject was a clothed dummy representing an "average" man 5 ft 10 in. in height and weighing 165 lb. The dummy was dressed in a two-piece suit, was in standing position, and had both arms at its sides.

The dummy was placed in a fixed position on the test floor and a line drawn in the facing direction, another line being drawn making a 45-deg angle with the facing direction. Shape factors were then determined at intervals of 1 ft out along each of these lines to a distance of 18 ft from the dummy. In obtaining shape factors a mechanical integrator was placed at each of the designated points on the floor, and a light beam from the integrator was used to trace the outline of the dummy. Corresponding to each closed curve traced by the light beam, the integrator would draw a closed pencil curve; the area of the pencil divided by a constant of the integrator was then taken as the shape factor of the dummy with respect to energy emitted from the point on the floor at which the integrator was then located.

The results show that floor areas more than 5 ft from the occupant emit less than 2 per cent of their energy in a direction such that it will be received by a perfectly absorbing (black body) occupant. Areas more than 7 ft away provide less than 1 per cent direct radiant transfer, whereas areas more distant than 10 ft provide less than $^1/_2$ per cent direct radiant transfer. For equal distances from the occupant, points along the semiprofile transmit 10 per cent to 15 per cent less energy to the occupant than do corresponding points (or rather infinitesimal areas) along the line corresponding to a full-face view.

The use of shape factors of this type is needed for exact studies of stability of comfort conditions in a room that is heated or cooled by radiant or partially radiant means, or for stability studies in a convection-heated room in which single-glass or other surfaces reach equilibrium temperatures lower than the room air temperature.

Steam-Power Generation

Latest Technique for Quick Starts on Large Turbines and Boilers, by J. C. Falkner, Mem. ASME, D. W. Napier, and C. W. Kellstedt, Consolidated Edison Company of New York, Inc., New York, N. Y. 1950 ASME Spring Meeting paper No. **50—S-1** (in type; to be published in Trans. ASME).

THE principle of the quick-start procedure is simple and consists of admitting steam into a turbine at a temperature equal to or slightly higher than the metal temperature of the turbine steam chest. With the turbine generator operating at a turning-gear speed of 3 rpm, the turbine can then, as a matter of routine, be brought up to speed and synchronized 15 the bus with absolute safety in 12 to to min. The present practice is to load the unit in such a way that the rate of increase in the turbine steam-chest-metal temperature will not be over 100 F per hr.

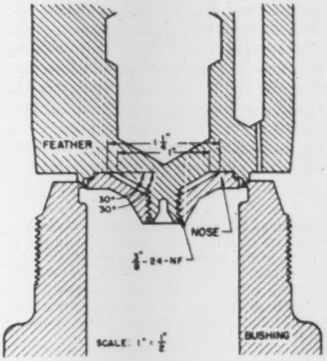
Since the presentation of the first paper in June, 1947, the practice of quick-starting topping units has been continued with improved technique, due mostly to better synchronizing of the operators' moves on the boilers, turbines, and high board. As of April 19, 1949, the number of quick starts made on the Waterside four topping units are as follows: 66 starts on No. 4–Westinghouse 53,000-kw unit; 49 starts on No. 5–General Electric 53,000-kw unit; 36 starts on No. 6–Westinghouse 65,000-kw unit; and 37 starts on No. 7–General Electric 65,000-kw unit.

It has been calculated that if quick-starting could be reduced to 15 min or less on all topping and condensing machines on the Consolidated Edison System, an annual saving of approximately $250,000 would result. This saving is made up of auxiliary power, stack and river losses, and fuel fed to the furnaces.

In addition to the operating saving just mentioned, there are many practical advantages which result from quick-starting. A notable instance occurred on August 27, 1948, when the Manhattan Cooper Square network was de-energized because of failures of generator cables in Waterside No. 2, causing a simultaneous outage of three out of the four topping units in this station. As soon as the first generator cables were temporarily repaired on unit No. 4, this machine was brought up to speed and was generating power in less than 15 min, and the network re-energized. If the old original 3-hr start had still been in vogue at the time, the network would have remained out of service at least $2^1/_2$ hr longer.

Sealing of High-Pressure Steam Safety Valves, by R. E. Adams, Battelle Memorial Institute, Columbus, Ohio, and J. L. Corcoran, Mem. ASME, Manning, Maxwell & Moore, Inc., Bridgeport, Conn. 1950 ASME Spring Meeting paper No. **50—S-24** (in type; to be published in Trans. ASME).

THE essential elements of a safety valve, in so far as sealing is concerned, are the feather and the seat bushing. The seat bushing is simply a hollow tube connected to the boiler, with a carefully finished seat on the top surface, while the feather is essentially a cover with a similar seat held against the seat bushing by pressure from a spring. When the steam pressure on the bottom of the feather exceeds the force of the spring, the design of the valve is such that the feather pops up and steam is released until the pressure drops to a predetermined value. At that point the feather is forced down by the spring, and the valve is again closed.



ASSEMBLY DRAWING OF NEW-DESIGN VALVE SEAT

A fundamental investigation of sealing with high-pressure steam safety valves has shown that poor sealing is a result of self-induced growth of tiny initial leaks. Expansion of the leaking steam cools local areas of the valve seat, causing contraction of the seating surfaces in a manner which increases the size of the leak. A new design of valve seat was developed incorporating thin flexible seating surfaces. The cooling effects of the leaking steam were minimized by providing better heat transfer from the high-temperature steam. The new design resulted in considerable improvement in sealing, and service tests have shown excellent performance.

Properties of Thin-Walled Curved Tubes of Short-Bend Radius, by T. E. Pardue and Irwin Vigness, Naval Research Laboratory, Washington, D. C. 1950 ASME Spring Meeting paper No. **50—S-21** (in type; to be published in Trans. ASME).

FLEXIBILITY and stress-intensification factors have been measured for a series of U-bends and right-angle bends having values of $\lambda = tR/r^2$ between 0.04 and 0.14, with $r/R = 1/3$. A theoretical analysis and a corresponding experimental study have been carried out to determine the importance of omitting terms containing the ratio of the tube radius to the bend radius. Experimental work has also been performed to determine the effects of constraints at the ends of the bends. This latter problem has not been studied theoretically. Measurements were made on the foregoing types of bends with (*a*) straight sections, (*b*) one rigid flange and one straight section (this condition used for right-angle

bends), and (*c*) two rigid flanges attached to the ends of the bend.

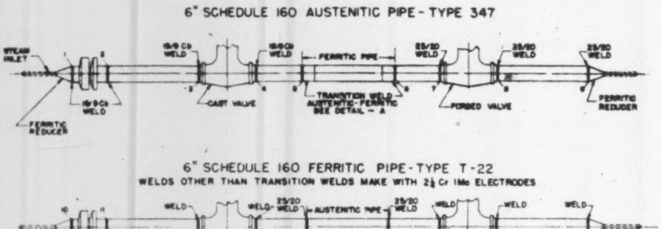
Reasonably good agreement between theory and experiment has been found for U-bends and 90-deg bends with straight sections of piping attached to the ends of the bend. Rigid constraints attached to the ends of the bend have been found to affect the measured quantities greatly.

Thermal Shock and Other Comparison Tests of Austenitic and Ferritic Steels for Main Steam Piping, by W. C. Stewart and W. G. Schreits, U. S. Naval Engineering Experiment Station, Annapolis, Md. 1950 ASME Spring Meeting paper No. **50—S-23** (mimeographed; to be published in Trans. ASME).

THERMAL-SHOCK tests have been conducted of 6-in. pipe and valve assemblies representing both type 347 and $2^1/_4$ Cr-1 Mo steels in 80 and 160 schedules. The nominal pipe-wall thickness for 80 schedule pipe is 0.432 in., and for 160 schedule pipe 0.718 in. Each assembly contained two valves, one cast and the other forged of similar composition to the pipe material.

The thermal-shock tests were designed to simulate the effect of carry-over of boiler feedwater into main steam lines operating at 900 or 2000 psi pressure, 1050 F temperature. The assemblies were shocked by introducing either 60 or 88 lb of boiler water at the saturation temperature along with the flow of superheated steam. Each assembly was subjected to 100 or more shocks. Temperature differentials in the pipe walls showed that the maximum temperature difference between the inside and outside of the wall was obtained for the ferritic steel assemblies. Moreover, the maximum temperature difference occurred in a much shorter time in the case of the ferritic steel. All thermal-shock specimens withstood 100 or more shocks without failure by rupture.

Other test procedures described include cyclic-deflection tests of full-size mock-ups consisting of 160 schedule pipe and valve for simulating expansion bends. Results are reported for mock-ups of both austenitic and ferritic materials which were tested at 2000 psi pressure, 1050 F temperature. Each assembly was subjected to 4000 or more deflections corresponding to expansion cycles that would obtain on heating a piping system from room temperature to 1050 F once every two days for approximately 20 years.


6" SCHEDULE 160 AUSTENITIC PIPE - TYPE 347
STEAM INLET
FERRITIC REDUCER
18/8 Cb WELD
18/8 Cb WELD
18/8 Cb WELD
CAST VALVE
FERRITIC PIPE
TRANSITION WELD AUSTENITIC-FERRITIC SEE DETAIL - A
25/20 WELD
25/20 WELD
25/20 WELD
FORGED VALVE
FERRITIC REDUCER
6" SCHEDULE 160 FERRITIC PIPE - TYPE T-22
WELDS OTHER THAN TRANSITION WELDS MAKE WITH 2½ Cr 1Mo ELECTRODES
WELD
CAST VALVE
25/20 WELD
AUSTENITIC PIPE
NOTE ①
FORGED VALVE
6" SCHEDULE 80 AUSTENITIC PIPE - TYPE 347
25/20 WELD
18/8 Cb WELD
FERRITIC REDUCER
CAST VALVE
FORGED VALVE
6" SCHEDULE 80 FERRITIC PIPE - TYPE T-22
WELDS MADE WITH 2½ Cr 1Mo ELECTRODES
WELD
CAST VALVE
FORGED VALVE
30°
60°
.718"
FIRST LAYER 25/20
18-8Cb SOLID TAPERED BACKING RING
DETAIL "A"
AUSTENITIC - FERRITIC TRANSITION WELD JOINT
NOTE ①
BUTT WELDED BETWEEN FERRITIC AND AUSTENITIC PIPE - PREHEATED TO 300° F ON FERRITIC SIDE - NO POST HEAT TREATMENT OF COMPLETED WELD

DETAILS OF THERMAL-SHOCK TEST SPECIMENS

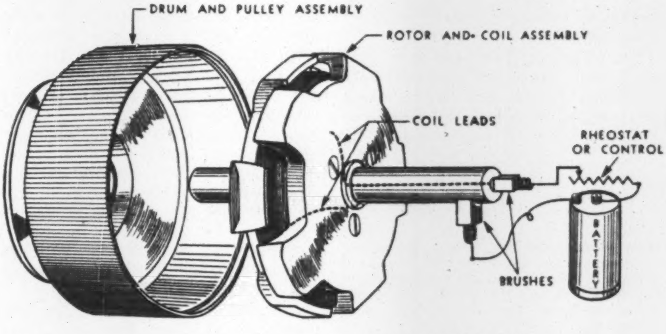
Machine Design

Electric-Induction Drives for Machinery and Vehicles, by Martin P. Winther, Eaton Manufacturing Company, Cleveland, Ohio. 1950 ASME Spring Meeting paper No. **50—S-15** (mimeographed).

ACCORDING to the paper, the electric-induction coupling not only can equal the hydraulic coupling in smoothness, but lends itself, in addition, to extremely fine control in smoothness of pickup, control of torque, and control of output speed. The high lights concerning the value of the electric-induction drive, and an understanding of the operation and application of this industrial device, are given.

Operation of the electric-induction or dynamatic drive is as follows: Torque delivered by the drive is a function of the total magnetic flux and the rate of slip between the surfaces of the field and the inductor drum. When there is no difference in speed between the two members, no torque is generated as there is obviously no movement of flux lines through the inductor drum. As the relative speed between the two members increases from zero, the torque developed increases with extreme rapidity until the maximum is obtained, after which the torque levels off and increased slip makes no appreciable change.

Speed control is accomplished in various ways, but the most common is that of controlling excitation to the magnetized member of the coupling through the medium of electronic tubes. An alternating-current supply is fed to a small power pack comprising grid-controlled rectifier tubes, and they in turn are governed by a pair of grid-controlled tubes similar to those used in radios, although of the industrial type. The grid of the control tube is caused to add or subtract current to the magnetizing coil with a slight variation in speed of the output shaft of the coupling. A small permanent-magnet alternating-current generator attached to the output shaft of the coupling delivers the signal to the electronic tubes for controlling the speed. A small rheostat, placed at the operator's station, or on the electronic control panel,



EXPLODED VIEW OF TYPICAL EATON DYNAMATIC DRIVE

adjusts the governing voltage, and speed of the output shaft is held to within relatively few revolutions per minute of the selected speed through a large range of power variation.

Where torque is required to be controlled rather than speed, the same type of electronic system for excitation described for speed control is used.

Cable-Pulley Friction, by W. E. Schorr, Jun. ASME, New York University, New York, N. Y. 1950 ASME Spring Meeting paper No. **50—S-17** (in type; to be published in Trans. ASME).

THE factors contributing to the friction in cable-pulley or rope systems are analyzed, and it is found that the friction in these systems increases as follows: With increase in cable tension (linearly), with increase in angle of cable bend, with increase in cable diameter, and with decrease in pulley diameter.

An empirical equation in reduced form for determining the total dynamic friction in cable-pulley systems for most applications is

$$F_r = T\left\{\frac{d^{1.92}}{D^{1.45}} + f_b'(2 - 2\cos\theta)^{1/2}\right\}$$

$$\theta \geqq \theta_c$$

A critical angle of cable-bending friction exists above which the friction becomes independent of increased cable wrap. The value of this critical angle depends upon the cable-pulley combination involved.

A maximum value of cable-bending friction exists at angles of cable bend equal to or greater than the critical angle.

The coefficients of friction for ball bearings under actual service conditions are higher than those usually listed. The friction due to the bearings may therefore become a substantial part of the total friction in cable-pulley systems.

A Precision Lens-Testing and Copying Camera, by W. W. Larue, Bell & Howell Company, Chicago, Ill. 1950 ASME Spring Meeting paper No. **50—S-19** (mimeographed).

IN general, no serious problems were encountered in the design of this camera, since it was found that the considerable experience already available was sufficient to attack the design in a straightforward manner. It was found that there were no compromises required in order to obtain the necessary features. For example, one problem in the design of a commercial camera is the minimizing of bulk and weight without sacrificing rigidity and accuracy to any great extent. This is a difficult compromise and some reduction in rigidity and accuracy always occurs. Fortunately, this compromise was unnecessary in this camera since bulk and weight were not objectionable and it was therefore possible to concentrate solely on the desired precision. Surprisingly enough, the completed design was neither as bulky nor heavy as expected when the design was first begun. In only one case was a compromise necessary to obtain a desirable feature. This compromise consisted of eliminating backlash in the focusing knob without resulting in an inconveniently high force to turn it. This was solved satisfactorily by making the diameter of the knob fairly large and by making the backlash mechanism adjustable. In this manner, it was possible to adjust the mechanism to just the tightness required for it to function correctly.

In spite of the final precision which was required, few close tolerances were required. It was necessary that the camera-lens seat be accurately parallel to the photographic plate. Since both the lens support and the camera back were to be located by "V" ways, this necessitated keeping only the ways straight and grinding the lens seat and plate-locating buttons parallel to each other and perpendicular to the axis of the ways. The only remaining precision work was that necessary on the focusing knob thread to keep the lead consistent throughout its length.

The completed camera fits the standard Bell and Howell optical bench, which consists of two $1^{1}/_{2}$-in-diam rods, by means of interfitting metal baffles between the lens support and camera back, and between the camera back and the plateholder mounting. There is no shutter in the camera since the exposures to be made are of long duration and require only that an opaque card be removed and replaced at the front of the lens. If exposures of less than one second were to be made, a lens with an integra shutter would be used.

Process Industries

Plant Location in the Process Industries as Determined by Economic Considerations, by Robert S. Aries, R. S. Aries & Associates, Brooklyn, N. Y., and Prof. Donald F. Othmer, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1950 ASME Spring Meeting paper No. **50—S-28** (mimeographed).

BASICALLY, location of a process industry depends upon the cost of carrying out the process at a given location as balanced against the relation of that location to (1) raw-material supplies, and (2) markets—that is, production costs and transfer costs.

In many process industries, considerations of production cost govern selection of a site. Thus a mineral-extraction plant is located with an eye to minimizing the cost of getting the mineral, which in turn depends on the richness of the area and its accessibility. In other industries, labor costs (based on wage rates and productivity of labor) or tax rates are dominant factors in determining production costs and thus locations. Finally, in settling upon the precise location of any activity within a local area, rent or land costs are sometimes the dominant factor.

For products of a perishable or bulky character, or those requiring close attention in their marketing, any location of the process not in immediate proximity to the market is out of the question.

Basic process-material manufacturers, on the other hand, sell their products directly to the ultimate consumers only to a relatively small extent. Goods are usually channeled through a succession of intermediary stages of production and subsequently to consumers. The development of this complex marketing organization promoted by modern transportation has enabled manufacturers to locate at a distance from resources and to serve wider markets.

Some process industries enjoy little freedom of location, as a cheap and ready access to raw materials, fuel, power, or markets may be predominant factors. For example, since ethylene cannot be transported economically at present, plants making ethylene glycol for "permanent" type antifreeze should be located near petroleum refineries or cracking units. Commonly, however, several factors are important in the location, providing a wider field for judgment.

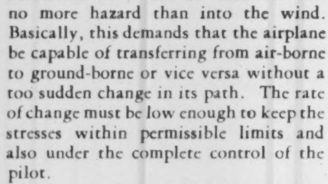
Aviation

The Development of Cross-Wind Undercarriages for Airplanes, by J. H. Geisse, aviation consultant, Washington, D. C. 1950 ASME Spring Meeting paper No. **50—S-29** (mimeographed).

A CROSS-WIND undercarriage is in its broadest sense any undercarriage which enables the pilot to land and take off across the wind with no more skill and no more hazard than into the wind. Basically, this demands that the airplane be capable of transferring from air-borne to ground-borne or vice versa without a too sudden change in its path. The rate of change must be low enough to keep the stresses within permissible limits and also under the complete control of the pilot.

This presents a problem because the airplane velocity relative to the ground, while it is air-borne, may have a substantial component perpendicular to its longitudinal axis. This may be due to drift resulting from cross winds, or in the absence of wind, it may be due to a skid or slip resulting from the setting of the airplane's controls. Under such conditions the airplane is not moving in the direction in which it is pointed. On the other hand, when the airplane is on the ground, it can move only in the direction in which it is headed if the main wheels are fixed parallel to the longitudinal axis. A rapid change either in the heading, or the path, or both, is therefore required during the transition from air-borne to ground-borne.

The purpose of this paper is to present a somewhat briefed story of the development of cross-wind undercarriages for airplanes. It includes a definition of what constitutes a cross-wind gear, some historical material, an explanation of the need for such undercarriages, a résumé of the development work sponsored by the Civil Aeronautics Administration, and a brief summary of what this development can mean to the aviation industry and to the taxpayer.



SECTION OF FIRESTONE CROSS-WIND GEAR

Wood Technology

How Mechanical Efficiency Is Being Increased in the Southern Pine Industry, by E. R. Schindler, Southern Pine Association, New Orleans, La. 1950 ASME Spring Meeting paper No. **50—S-30** (mimeographed).

GREATER production, necessary to compensate for wage increases, must be attained through the use of more efficient production methods. There are three fundamental phases of lumber-manufacturing processes, any one of which can reflect great savings through a well-planned mechanized program. First, the woods operation; second, the saw and planing mill; and third, the yarding, handling, and transportation of lumber.

The approach to economical log handling is based on numerous considerations. Log sizes, nature of terrain, time element, and money are but a few.

Tractor logging is comparatvely young and while tractors and allied logging equipment have been used for years in the more heavily timbered areas of the South, these new methods are now taking hold in other sections where smaller timber is being harvested. Track-type log trailers, cruisers, and arches lend themselves unusually well to selective logging practices.

Portable power saws for felling and bucking present new opportunities for the logger.

Many improvements have been made in power chain-saw equipment. The weight factor which was the principal objection to the earlier models has been reduced due to the employment of stronger and lighter materials. Logging crews operating power-driven saws demonstrated that the job of felling and bucking timber is increased in speed and efficiency many times.

Mechanical tree planters are revolutionizing reforestation methods by planting at amazing rates. Demonstrations have proved actual planting at the rate of 10,000 seedlings per eight-hour day.

Although there were few fundamentally new developments in sawmill design during recent years, a number of refinements in the construction of band and circular saws, edgers, resaws, and trimmers have been made which resulted in an important cumulative effect in improving these machines. Similarly, planing-mill machinery employing ball and roller bearings, direct motor drives and improved steels, together with improvements in design, have made these machines capable of operating at much higher speeds than those of former years.

Either automatic or semiautomatic sorting tables can be used very effectively in the handling of lumber. The semiautomatic type in which the sorter turns the lumber edgewise and drops it into the proper slot is less expensive and has advantages over the automatic type, because in most cases the latter separates lumber by length only, rather than by width or thickness. The use of mechanical stackers and unstackers for handling lumber to be either air or kiln dried also displaced a considerable amount of labor. Tractors, straddle and fork trucks can likewise greatly facilitate the handling of lumber because of the volume that can be moved.

Some very striking cases of efficiency have been achieved since the Southern Pine Association adopted its program advocating greater mechanization. Many lumbermen have eliminated needless production delays, reduced total processing time, and saved labor by the appliance of more economical methods, which required better plant and woods equipment.

Some of the short cuts, therefore, to greater efficiency include: (1) More economical plant layouts, (2) extensive use of mechanical handling equipment, (3) employment of better sawing methods, (4) more efficient power generation and transmission, (5) improved lumber-drying techniques, and (6) elimination of unsafe working conditions.

Postwar Developments in Forest-Products Research, by C. A. Rishell, Timber Engineering Company, Washington, D. C. 1950 ASME Spring Meeting paper No. 50—S-34 (mimeographed).

APPROXIMATELY 12,500 wood-research projects have been completed or are being currently undertaken. Out of this total, 45 per cent of the projects have been in the chemical and chemical-products field; 15 per cent in processes, materials, and devices used with wood in order to improve or modify its properties and use; 11.3 per cent in the field of primary timber and lumber products; 8.7 per cent of the projects have been devoted to structure, identification, and properties of wood; 10.7 per cent to fabricated wood products; 6 per cent to building, building parts, and other structures; and $2^1/_2$ per cent to means and devices for the selection of wood.

There are 118 colleges and universities in the United States conducting wood research, 97 federal and state organizations, 238 manufacturers of forest products, 868 processers, consumers, and materials suppliers, 201 professional societies and commercial laboratories, and 98 trade associations, all of whom are undertaking wood research in some form or other.

Some necessary research, as listed in the paper, is as follows: Surveys to determine quantity, location, and form of waste wood; a more comprehensive compilation of all known research in wood; research to develop processes for stabilizing wood to resist shrinking and swelling; research in lignin; elimination of defective material from low-grade lumber at the source of production rather than in the fabricator's plant; improvements in drying and pressing equipment for hardboards from wood waste; improved design for woodworking equipment; new fast adhesives, particularly of the waterproof variety, and simple inexpensive equipment for obtaining required clamping pressures, especially for curved members; and inexpensive (portable and permanent) equipment for debarking small logs, slabs, and other sawmill and wood waste.

Machines and Forestry, by Anthony P. Dean, U. S. Department of Agriculture, Washington 25, D. C. 1950 ASME Spring Meeting paper No. **50—S-32** (mimeographed).

IT is generally recognized that improved forest management is necessary to provide an adequate supply of raw material for the forest industry of the future. Consequently, government, industry, and other forest owners are giving increasing attention to ways and means of accomplishing better forest practices.

Intensive forestry is being successfully practiced by many forest landowners but would have more widespread application if mechanized to a greater degree. While machines are used extensively for building roads and logging, silvicultural measures and forest protection still require considerable hand labor. Much of the work is arduous and it is costly.

While forestry may be highly mechanized in some respects, mechanization has not kept pace with other developments in the field of forestry. Forest-fire fighting has been mechanized to a remarkable degree, but it still takes thousands of man-days every year and is costly.

The ideal approach would be a plan whereby the professional foresters and engineers would get together to search out and appraise the bottlenecks that are standing in the way of good forest practice. This would help to prepare both groups for the attack on the problem of what to do about the bottlenecks after they are discovered. Before reaching the point where real progress will be made, the engineers need to learn the limitations placed by the forester on the use of equipment, and foresters need a better appreciation of what the engineers can do with machines.

Wood-Cutting Tools and Equipment, by Thomas D. Perry, Fellow ASME, Moorestown, N. J., and F. Powell Forbes, Mem. ASME, Weyerhaeuser Timber Company, Newark, N. J. 1950 ASME Spring Meeting paper No. **50—S-35** (mimeographed).

IT was felt that the ASME could contribute substantially to a project of investigating wood-cutting tools and equipment by promoting and sponsoring a working committee on "Wood-Cutting Tools and Equipment." This eventual committee, when formed, will consist of representatives jointly selected by toolmakers, machine manufacturers, and machinery users.

A temporary committee was formed by volunteers interested in furthering the project, who represented various phases of the subject, i.e., those who made and used these woodworking tools and machines.

It has been the avowed purpose of the volunteer members of this committee to concentrate on publicizing the demonstrable need of this study in this field of possible standardization, and to persuade the industry to use the sponsorship of the ASME as a most interested, but wholly impartial organization, operated on a broader technical base than any individual industry can otherwise hope to supply. An added advantage is the close cooperation of the ASME with the American Standards Association and the American Society of Testing Materials, whose aid would be invaluable in establishing desirable prestige and wide recognition for constructive work in this field.

In order to publicize the need for work in this field, one phase of one problem was selected for a preliminary survey.

The problem was the relationship of circular-saw size to the diameter of the arbor hole required for mounting the saw on various types of machines.

In order to determine the facts, a brief questionnaire was prepared and sent to 164 representative machine manufacturers who supply standard new arbors in their machines.

Returns representing 64 machine manufacturers reported on a total of 280 types of saw arbors. Certain machines reported had several saw arbors, sometimes of different diameters. Others had diamond-shaped or square arbors, rather than round arbors.

The paper emphasizes that it is exceedingly difficult to believe that such a wide range of arbor sizes is economically necessary or justifiable.

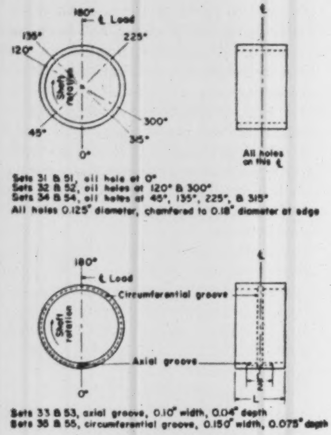
This is only one relatively simple problem in a big field.

It is possible that the industries involved do not realize such inconsistencies. If such is the case, it is a challenge to these industries to initiate steps that will correct such an illogical condition.

Lubrication

Oil Holes and Grooves in Plain Journal Bearings, by S. A. McKee and H. S. White, National Bureau of Standards, Washington, D. C. 1950 ASME Spring Meeting paper No. **50—S-9** (in type; to be published in Trans. ASME).

DATA are presented showing the performance of plain journal bearings having various arrangements of oil holes and grooves operating in a four-bearing friction machine with forced-feed lubrication. Tests cover operation where the oil is fed through the bearing shell by means of five arrangements, including one, two, or four oil holes; one axial or one circumferential groove. Tests were also run with three arrangements for feeding oil from the center of a hollow shaft. These were one or two oil holes in the shaft, or one oil hole terminating in a flat on the surface of the shaft. Two clearance-diameter ratios were used with each arrangement. Test runs were made at constant speed and at a number of loads which were unidirectional relative to the bearings. The data cover operation with one oil at one oil-inlet temperature and two speeds. In some of the tests the loads were increased until unstable lubrication was reached. The test results include the frictional characteristics, values of ZN/P at transition be-


180°
℄ Load
135°
120°
225°
Shaft rotation
300°
45°
315°
0°
℄
All holes on this ℄
Sets 31 & 51, oil hole at 0°
Sets 32 & 52, oil holes at 120° & 300°
Sets 34 & 54, oil holes at 45°, 135°, 225°, & 315°
All holes 0.125" diameter, chamfered to 0.18" diameter at edge
180°
℄ Load
Circumferential groove
Shaft rotation
Axial groove
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Sets 33 & 53, axial groove, 0.10" width, 0.04" depth
Sets 35 & 55, circumferential groove, 0.150" width, 0.075" depth

ARRANGEMENTS OF OIL HOLES AND GROOVES IN BEARINGS

tween stable and unstable lubrication, and data on thermal behavior and on oil flow. A summary of the general behavior of the various arrangements is given.

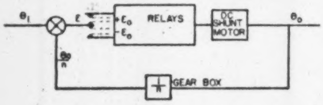
Film Thickness Between Gear Teeth, by M. D. Hersey, Fellow ASME, U. S. Naval Engineering Experiment Station, Annapolis, Md., and D. B. Lowdenslager, University of Virginia, Charlottesville, Va. 1950 ASME Spring Meeting paper No. **50—S-10** (in type; to be published in Trans. ASME).

THIS investigation completes a solution, undertaken by K. G. Karlson in his little-known Swedish paper of 1926, for the oil-film thickness between gear teeth. Karlson's problem is characterized by the use of a parabolic curve for the viscosity-pressure relation. The numerical results here obtained are comparable with those previously published by Gatcombe, who used a more conventional viscosity-pressure formula. It is hoped that the present analysis will help to clarify the assumptions and calculations required in the hydrodynamic theory of gear-tooth lubrication. As an aid to its practical application, the relative film thicknesses found for geometrically similar pairs of gears are here shown by a chart constructed in terms of the appropriate dimensionless variables, and extending from zero to 10 microinches per in. of pitch diameter of the pinion. The limiting case of a lubricant whose viscosity is unaffected by pressure, for which an analytical solution had been given by Karlson, is represented by a straight line on this chart.

Instruments

Relay Servomechanisms—The Shunt-Motor Servo With Inertia Load, by T. A. Rogers and W. C. Hurty, University of California, Los Angeles, Calif. 1950 ASME Spring Meeting paper No. **50—S-13** (in type; to be published in Trans. ASME).

THIS paper develops the theory of the shunt-motor relay servomechanism in terms of dimensionless motor parameters. Operating curves are drawn in the phase plane illustrating the effect of parameter changes on the stability of the servo for three forms of input signal. The first two forms of input signal, a step function and a uniform variation with time, have been discussed before and are included only for completeness. The third form of input signal, a sine function, is of most interest and is treated at greater length. The phase-plane curves, obtained from a differential analyzer, show three modes of operation which have been related to the servomechanism parameters by a relatively simple expression.



SCHEMATIC OF A RELAY SERVO

Plastics

Effect of Fuel-Immersion on Laminated Plastics, by W. A. Crouse, Margie Carickhoff, and Margaret A. Fisher, National Bureau of Standards, Washington, D. C. 1949 ASME Fall Meeting paper No. **49—S-32** (in type; published in full in Trans. ASME, February 1950, page 175).

THE effects of cyclic and of continuous immersion in heptane, toluene, and SR-6, a test fuel, on the weight, dimensions, and flexural properties of nineteen samples of laminated plastics are reported. No one sample exhibited smaller changes than all other samples in all properties for all fuels and for both cyclic and continuous immersion. The best weight and dimensional stability in the cyclic test was shown by a glass-fabric unsaturated-polyester laminate. The changes in flexural strength as well as in modulus of elasticity were losses in the majority of cases after the cyclic and the continuous-immersion test. The unsaturated-polyester laminates varied widely among themselves in regard to the magnitude of the changes in a given property after an immersion test.

ASME Transactions for May, 1950

THE May, 1950, issue of the Transactions of the ASME contains the following:

TECHNICAL PAPERS

The Coal-Hydrogenation Demonstration Plant at Louisiana, Md., by J. A. Markovits. (49—PET-3)

High-Pressure Vessels in Coal-Hydrogenation Service, by J. T. Donovan, M. Josenhans, and J. A. Markovits. (49—PET-6)

High-Pressure (10,300 Psi) Piping, Flanged Joints, Fittings, and Valves for Coal-Hydrogenation Service, by J. H. Sandaker, J. A. Markovits, and K. B. Bredtschneider. (49—PET-2)

Instrumentation for Coal-Hydrogenation Service, by G. L. Bruno, F. W. Geyer, and J. A. Markovits. (49—PET-4)

Metallurgical and Fabrication Considerations in the Coal-Hydrogenation Demonstration-Plant Construction, by B. H. Leonard, Jr., G. D. Gardner, and J. A. Markovits. (49—PET-5)

Design of Preheaters and Heat Exchangers for Coal-Hydrogenation Plants, by P. W. Laughrey, W. I. Gwillim, H. Schappert, and J. A. Markovits. (49—PET-1)

A Simple Hydrodynamic Thrust Bearing, by F. R. Archibald. (49—A-29)

Density-Pressure Relationships for Two Low-Viscosity Dimethyl Siloxanes, by S. B. Gunst. (49—A-91)

A Mathematical Evaluation of Pressures in a Grease-Lubricated Bearing, by K. B. Lawrence. (49—A-69)

Investigation of Lubricants for Power Circuit Breakers, by R. R. Bush. (49—A-17)

Heat Transfer to Superheated Steam at High Pressures, by W. H. McAdams, W. E. Kennel, and J. N. Addoms. (49—A-32)

Philadelphia Electric Company Adopts Mobile Coal-Handling Equipment, by E. C. Russell. (49—A-63)

Storing and Reclaiming Coal With Earth-Moving Equipment at the Oswego Steam Station, by J. N. Ewart. (49—A-98)

Vibration of Marine-Turbine Blading, by R. W. Nolan. (49—A-76)

Theory of the Mechanical Properties of Hot Plastics, by S. J. Loring. (49—A-60)

Extrapolation of Static Tests to Predict Operation of Jet Engines in Flight, by C. A. Meyer.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Manufacturing Economy

COMMENT BY E. N. BALDWIN[1]

The writer is in agreement with the contents of the paper[2] and, therefore, can only amplify the points made by the writer.

The theme of the paper might be restated: "An engineer cannot design effectively unless he knows how the part is to be made." The materials and processes to be used to make the parts or apparatus should be considered during initial layout and study of the design. In many organizations, the layout of the apparatus and details have been drawn before the manufacturing personnel make their suggestions. This procedure often prevents the pattern maker, the tool maker, the methods man, the process and materials engineer, and the shop supervisors from making suggestions which might change the design radically. Therefore, these men should be consulted in the initial stage of the development. When the idea has been placed on paper in the form of a layout, each detail should be discussed and its function, method of manufacture, materials, finishes, and tolerances agreed upon by the interested parties.

The designer should systematically consult each person affected and thus work into his design the most economical materials and processes.

Some companies form committees with representatives from the engineering, shop, and sales departments who go over proposed designs carefully. These committees educate the members of these departments on each other's problems and serve as an effective means for making changes in designs which cause changes in tools, patterns, and parts. No detail is too small for the consideration of this committee, because a change in a drawing is much less expensive than a change after the part is in production. Such committees also serve to develop leadership. The chairman may be a member of any department.

Also, if special tooling and production equipment are required to effect economies, a solution can be worked out together so all parties understand the necessity of this special equipment and are willing to be responsible for its successful operation and financing.

In order to make sure that nothing is overlooked for the consideration of the committee, a similar series of questions should be available or compiled as those outlined in the paper. These questions should be answered in full concerning each part, material, and process, and should be considered by each member reviewing the design. Questions serve as a stimulant to thinking and reveal such items as standardized processes which may be inadequate. It is common knowledge that, as soon as a part is designed and in production, improvements are discovered. These improvements could have been incorporated in the design if more questions had been asked and the factors seriously considered.

The examples given in the paper seem self-evident, and one wonders why the design was not made according to the second method in the first place. A designer who asks questions and considers all factors of materials and processes can approach the optimum design and encounter very few improvements that should be made after the design is in production.

One reason for lack of consideration on the part of the designer is that he is unfamiliar with many processes and the principles which are used within these processes. For example, stretch-bending does not require expensive tools or equipment and can produce parts bent to the right shape with the minimum of springback. A tabulation of the various kinds of processes with their essential features such as range in size of materials handled, tolerances possible, and other factors, would be very helpful to a designer in selecting the various processes to make his parts.

The designer is responsible for making the decisions as to the materials chosen and the form of the parts designed. Therefore, he controls largely the processes which are used. These processes, in turn, determine the cost of his design, and he should have a clear idea of the relative material and labor costs entering into the processes. For example, he should have a good conception of the amount of labor it requires to make a mold for a casting in a foundry, as compared with the amount of labor required to cut and weld a weldment. After long experience, a good designer knows and thinks about these facts instinctively. Every effort should be made to train young engineers in an organization by placing them on committees where they come in contact with men who know facts on materials and processes.

COMMENT BY E. L. MIDGETTE[3]

A designer of mechanical components, which are to be mass-produced, could ill afford to overlook any of the considerations discussed by the author. This paper was read essentially from the viewpoint of a teacher of machine design, albeit one who has had the opportunity actually to design considerable material for production. Because of this fact, the considerations discussed in the paper have meant a great deal to the writer. Certainly, no design can be considered good unless it can be transferred into actual metal with facility and economy. However, the writer is even more interested in this paper, as one who is attempting to teach the problems of design.

The paper clearly illustrates that any design has to meet two basic sets of requirements, namely, that it function in a way to satisfy the engineering requirements of the part, and that it lend itself to economical manufacturing. Most teaching is concentrated on the first of these two requirements, treating it as if it were the major one, whereas this paper clearly demonstrates that the second is of co-ordinate importance rather than a secondary consideration. The real problem presented by this paper to those of us interested in teaching is what can be done in our classes to insure that the graduating mechanical engineer is equally aware of the two basic requirements of a design; that it be functionally correct, and admit of economical manufacture.

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[1] George Westinghouse Professor of Production Engineering, The Pennsylvania State College, School of Engineering, State College, Pa. Mem. ASME.

[2] "Design Considerations for Manufacturing Economy," by R. W. Bolz, MECHANICAL ENGINEERING, vol. 71, December, 1949, pp. 1004–1010.

[3] Professor of Mechanical Engineering, Head of Department, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Mem. ASME.

COMMENT BY O. A. WHEELON[4]

This paper drives home the points that everyone should keep in mind but frequently overlooks. Too often we hope that the material will do what we want, or that tolerances and finishes we desire can be met, without taking full account of the limitations of the materials and processes involved. This wishful thinking is costly. Either we have to go back and reconcile the design, add additional expensive operations, or take the penalty of high rejection costs. Facing these manufacturing "facts of life" does much to minimize costs from this source.

The writer most heartily endorses the concept, "the designer establishes the minimum manufacturing cost." Far too many times improper sequence of operations, tooling, or processing has tended to hide the importance of design from a cost standpoint.

Simplicity in design deserves a great deal of emphasis. We do, however, need a better definition of simplification. There have been many abortive attempts under this banner. While the writer would not attempt to define it, he would like to inject an added thought along this line. In simple components that are easy to comprehend, we can understand the problem and see the areas that require special attention. These components start at a lower unit labor cost, and they will achieve basic time much sooner than usual. The opposite effect is often encountered in those components that are so complex that the true nature of the problem and the troublesome points are not recognized until a considerable manufacturing disturbance has developed.

In aircraft work we are seldom blessed with an experimental model upon which to concentrate on functional performance, and then to have sufficient time to redesign for production. Of course some manufacturing convenience changes are made to take care of the serious "misses," but they are held to a minimum. This situation necessitates the production-design aspects be carried concurrently with the normal design.

Our belief is that this can best be done by having design personnel "production conscious" rather than to have production design "kibitzing" and review of drawings. Production-design personnel are available or on call for advice, cost analysis, etc. They also call in processing, tooling or manufacturing personnel when necessary. In this way the design groups carry the full design responsibility and minimize the difficulties of split responsibilities. Not all aircraft firms work in this manner. However, the writer is convinced that it has the best chance of success over a long period of time.

It would be well if more papers of this quality could be brought out. The author has done an excellent job of highlighting principles that are applicable to all industries. Perhaps the emphasis may change in different industries, but not the philosophy.

AUTHOR'S CLOSURE

The comments by Messrs. Baldwin, Midgette, and Wheelon actually require no rebuttal. Response from industry and educational institutions to this new philosophy in design is highly gratifying. However, the actual case histories to date emphasizing the dollars-and-cents value of this approach bear strongest witness to its practicability.

The erroneous idea that design for production applies effectively only where tremendous quantities are concerned in all probability is still a great barrier to application of these principles. It is a fact, nevertheless, that savings in the low-quantity, heavy-equipment field have been equally as impressive as those found in the higher mass-production areas. The key factor is that design must be compatible with quantity—as quantity multiplies, processes with increasingly greater tool-up costs can be brought into play.

Equally well emphasized has been the final fact that design plays the lead role, not tooling. The designer's specifications actually set the major limits beyond which no great percentage of cost reduction can be made regardless of the amount of tooling ingenuity brought into play. One recent base points up this factor emphatically in that tooling improvements were employed exclusively to achieve cost reductions for over twenty years. This method used intelligently resulted in an ultimate reduction of 10 per cent. Redesign of the piece to employ another method of production, ordinarily not even considered, resulted in an immediate cost reduction of 50 per cent while a following design revision lopped off another 10 per cent.

Such lessons are not just for the man in the other pew, they are eminently applicable to practically any manufacturer on the scene today. Better machinery at lower cost is the much sought end result. Management has the key, it requires but to promote and use it effectively.

R. W. BOLZ.[5]

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[4] Douglas Aircraft Company, Inc., Santa Monica, Calif.

[5] Associate Editor, *Machine Design*, Cleveland, Ohio. Mem. ASME.

Engineering Curricula

COMMENT BY JAMES R. GRIFFITH[6]

The author's opening statement relative to the steady increase in specialized branches of engineering is particularly pertinent and timely.[7] The writer knows of at least one undergraduate curriculum in electrical engineering where specialized courses have crowded out such basic applied-science courses as strength of materials. The writer has had occasion to work on many projects as a structural engineer on which the major problems were in electrical engineering. One such project was the Chicago Terminal electrification of the Illinois Central Railroad. The necessary details of design on catenary structures, foundations, retaining walls, and such were handled by the structural squad. Yet the chief electrical engineer had many decisions to make which required at least a basic knowledge of strength of materials if not the detailed application to structural-design problems.

The chief engineer of Fleischman's Yeast Company, a graduate mechanical engineer, 20 years ago was discussing some of his plant problems with the writer. He remarked that, while his major problems were in the mechanical-engineering field, a goodly share involved a knowledge of structural engineering.

The writer served 5 years during World War II as commander in the Civil Engineers Corps of the Naval Reserve. His problems as a public works officer involved mechanical and electrical engineering, as well as civil engineering. In fact he is unable to recall any of his responsible work which did not involve a reasonable knowledge of allied fields of engineering.

It is believed that many engineering educators are prone to overlook the needs of industry. Donald M. Baker, in an excellent paper,[8] has urged that engineering educational institutions give adequate attention to engineers as well as engineering. Mr. Baker advocates "broader scope of basic instructions in subjects that cover the entire field of engineering." He further states: "Every engineering graduate realizes—either upon graduation or very soon thereafter—that he has just begun to acquire the knowledge which he will need before he attains a position of responsibility in his profession."

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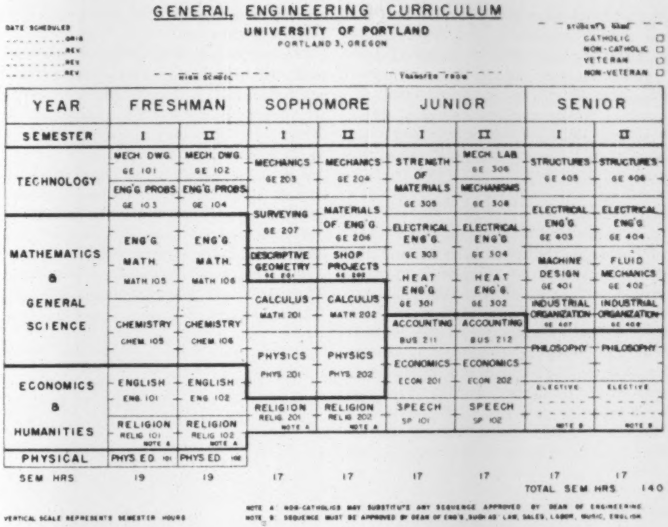
[6] Dean, University of Portland, School of Engineering, Portland, Ore.

[7] "Differentiating Characteristics of an Engineering Curriculum," by S. C. Hollister, MECHANICAL ENGINEERING, vol. 72, February, 1950, pp. 122–123.

The University of Portland, in organizing a four-year undergraduate curriculum in engineering in 1948, wisely decided to concentrate on a general engineering program. Some schools are offering a general engineering curriculum which more rightly should be classified as a business course rather than engineering, since their major field is in business. The curriculum offered at the University of Portland is basically in engineering and endeavors to give the necessary basic course in civil, electrical, and mechanical engineering. As will be seen from the curriculum diagram, Fig. 1 herewith, engineering work in the upper division is about equally divided between these three fields.

Maynard M. Boring[9] has complimented the University of Portland on the decision to offer the basic work in the three branches of engineering as best fitting the young graduate for industry. In fact, every industrial employer with whom the writer has discussed the matter has been enthusiastic over the prospect of such a course. The only adverse comment registered was from the personnel director of a local industry who had no conception of general engineering and the advantages thereof. His engineering superiors quickly realized the advantages of such a basic background.



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SEMESTER	I	II	I	II	I	II	I	II
TECHNOLOGY	MECH DWG. GE 101 ENG'G PROBS. GE 103	MECH DWG. GE 102 ENG'G PROBS. GE 104	MECHANICS GE 203 SURVEYING GE 207 DESCRIPTIVE GEOMETRY GE 201	MECHANICS GE 204 MATERIALS OF ENG'G. GE 206 SHOP PROJECTS GE 202	STRENGTH OF MATERIALS GE 305 ELECTRICAL ENG'G. GE 303 HEAT ENG'G GE 301	MECH LAB GE 306 MECHANISMS GE 308 ELECTRICAL ENG'G GE 304 HEAT ENG'G. GE 302	STRUCTURES GE 405 ELECTRICAL ENG'G GE 403 MACHINE DESIGN GE 401 INDUSTRIAL ORGANIZATION GE 407	STRUCTURES GE 406 ELECTRICAL ENG'G GE 404 FLUID MECHANICS GE 402 INDUSTRIAL ORGANIZATION GE 408
MATHEMATICS & GENERAL SCIENCE	ENG'G MATH. MATH 105 CHEMISTRY CHEM. 105	ENG'G MATH. MATH 106 CHEMISTRY CHEM. 106	CALCULUS MATH 201 PHYSICS PHYS. 201	CALCULUS MATH 202 PHYSICS PHYS. 202				
ECONOMICS & HUMANITIES	ENGLISH ENG. 101 RELIGION RELIG. 101 NOTE A	ENGLISH ENG 102 RELIGION RELIG. 102 NOTE A	RELIGION RELIG. 201 NOTE A	RELIGION RELIG. 202 NOTE A	ACCOUNTING BUS 211 ECONOMICS ECON 201 SPEECH SP 101	ACCOUNTING BUS 212 ECONOMICS ECON 202 SPEECH SP 102	PHILOSOPHY ELECTIVE NOTE B	PHILOSOPHY ELECTIVE NOTE B
PHYSICAL	PHYS ED 101	PHYS ED 102						
SEM HRS	19	19	17	17	17	17	17	17

TOTAL SEM HRS 140

VERTICAL SCALE REPRESENTS SEMESTER HOURS

NOTE A: NON-CATHOLICS MAY SUBSTITUTE ANY SEQUENCE APPROVED BY DEAN OF ENGINEERING

NOTE B: SEQUENCE MUST BE APPROVED BY DEAN OF ENG'G, SUCH AS LAW, SALES, LABOR, MUSIC, ENGLISH

Fig. 1 Diagram showing general engineering courses at University of Portland

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[8] "Some Thoughts on Engineering Education," by D. M. Baker, Trans. ASCE, vol. 112, 1947, pp. 745–766.

[9] Mechanical, Technical Parts Division, General Electric Company. Mem. ASEE. (Member of Council 1935–1938.)

Antifriction Bearings

Comment by Thomas Barish[10]

The author has given a capable and fairly complete review of the major issues involved in the selection of antifriction bearings for machine tools.[11] There are a few understressings and one or two contrasting viewpoints.

More data should be presented to the machine-tool designer indicating when ball bearings or roller bearings should be used. The roller bearing has much smaller deflections. For the same reason, they rarely can be preloaded as heavily, because the necessary control is far closer, and the setting is more easily spoiled by expansions and the like. Hence, the roller bearing usually has much smaller preloads. It is preferred for very heavy duty such as rough-cutting. The ball bearing is preferred for higher speeds, greater accuracy, and, lately, for jobs requiring large variations in speed.

Three-bearing mountings are frequently a necessity. A comparison of two and three-bearing mountings has been given in a previous paper by the writer.[12] A method for actually calculating the deflections of three-bearing spindles and their bearings, and comparing them with two-bearing spindles, is given in another paper of the writer's.[13]

More emphasis is needed on spindle diameter. Frequently a small increase in spindle diameter can do more than a third bearing. The last reference quoted gives such a case and its calculation. Also covered here is the problem of spindle length; frequently spindles are made too long. The optimum for a two-bearing mounting is from 3 to 5 diam.

The author proposes duplex ball bearings, mounted in a pair back-to-back, with a different contact angle for each half of the pair. Such a combination is useful for very limited conditions only. The axial rigidity is less than for two steep-angle bearings, and the radial rigidity is less than for two low-angle bearings. Hence, it should be used only for greatly varying loads. Even then, both rigidities can be nearly doubled by putting the bearings in tandem and opposing them by the bearing at the other end of the spindle.

The writer can strongly confirm the author's recommendation for integral inner races for very high-speed applications, having already made a very successful application like this on a high-speed gyroscope.

On feed screws, the proposed use of separate radial bearings and ball thrust bearings again introduces the usual problem of dividing the two kinds of load and of accuracies between the two groups of bearings. The writer's experience indicates that it is better to use larger angular contact bearings very heavily preloaded, and only one pair.

Cam-roller capacities are frequently

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[10] Consulting Engineer, Washington, D. C.

[11] "Selecting Antifriction Bearings for Machine Tools," by J. H. Baninger, Mechanical Engineering, vol. 72, 1950, pp. 134–136.

[12] "Ball Bearing Machine Tool Spindles," by T. Barish, Trans. ASME, vol. 50, 1928, pp. 1–8.

[13] "A New Method of Machine Tool Spindle Analysis," by T. Barish, Mechanical Engineering, vol. 61, 1939, pp. 813–816.

limited by the stress on the surface where the cam is contacted. Allowable loadings for this condition on standard ball bearings has been covered by the writer.[14] For reducing the race bending stress, it is better to use medium or heavy series bearings, and also the notch-filled type with more balls and the balls closer together.

COMMENT BY H. T. MORTON[15]

An important point developed by the author is that duplex pairs of angular contact ball bearings properly preloaded give best control of shaft rigidity and position. These pairs of bearings can be made more accurately, can be preloaded in excess of the expected axial load to prevent chatter, and can be mounted readily on the shaft and in the housing.

Double-row bearings are limited in the amount and accurate control of preload. For this reason, they are limited in speeds and preloads for control of spindle vibration, as compared to duplex pairs of bearings.

The use of bearings integral with the shaft for high-cycle-driven spindles has permitted use of larger-diameter shafts at higher speeds with a minimum of vibration. They may be used more often as their need arises.

For most spindles, standard dimensioned bearings made to standardized close tolerances are available or can be obtained, should quantities warrant it. The extra-light series allows larger shaft sizes and greater shaft rigidity. These standard bearings should be considered for new designs.

AUTHOR'S CLOSURE

Mr. Barish's comments are basically correct, but to recommend specifically the type of bearing best suited for different installations would not be good policy from the trade standpoint.

If a three-bearing mounting is a necessity, then provision should be made to take care of the alignment of all three bearings under most severe operating conditions; otherwise some of the bearings are bound to fail prematurely, as explained in the paper.

Duplex bearings mounted in a pair back-to-back having different contact angles are recommended *only* for certain installations, to prevent relieving *entirely* the preload of the bearing not subjected to the thrust load from the action of the cutting tool, etc., and thus is able to carry a certain percentage of the radial load.

For feed screws, the proposed use of separate radial bearings and ball thrust bearings gives the most rigid construction within the *smallest space*, which in most installations does not permit the use of large size bearings.

Ball bearings for cam rollers are determined by their capacity, which is greatly reduced on account of outer ring deformation due to line contact, and not due to surface stresses, hence notched race rings are not permissible. Bearings of light series having more balls than heavy series are better suited, but must have reinforced outer ring, hence less deformation and more capacity.

The author wishes to thank both Mr. Barish and Mr. Morton for their comments.

JOHN H. BANINGER.[16]

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[14] "Ball Bearings Used as Cam Rollers," by T. Barish, *Product Engineering*, vol. 8, 1937, pp. 2–5.

[15] Formerly Standards Engineer, The Fafnir Bearings Company, New Britain, Conn. Now President, Morton Bearing Co., Ann Arbor, Mich.

[16] Bristol, Conn.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Dynamic Equipment Policy

DYNAMIC EQUIPMENT POLICY. By George Terborgh. (A Machinery and Allied Products Institute Study.) McGraw-Hill Book Company, Inc., Toronto, Can., London, England, New York, N. Y., 1949. Cloth, 5¾ × 9 in., 11 tables, 8 charts, Glossary, xxiii and 290 pp., $3.75.

REVIEWED BY L. K. SILLCOX[1]

THIS book is an attempt to develop the basic principles for replacement of the tools of industry and the problems of procedure in making them function. It is not a treatise of engineering-economic studies with elaborate mathematical formulas and equations for determining durable goods used in production, but rather its purpose is to unfold simple tests of replaceability which are more reliable than the conventional rule-of-thumb decisions very common in American industry today.

We are under the impression that our enterprises are progressive and in the van when it comes to technological improvements. But in actual practice it is found many executives unhesitatingly discard useful and still serviceable tools for the latest and last word as it comes along, while others hold to their obsolete equipment much beyond its economic life. The author states that with the exception of a few simple cases, management has mediocre information upon which to base a progressive replacement policy. He also introduces surveys to indicate that there is poor organization, a lack of capital, and poor analytical devices in the field of replacement mechanization.

Among the analytic devices are many formulas for replacement programs but they are too complex for the average executive and they yield widely different results when applied to the same group of facts. Some of the more common in current use are the "minimum-average-cost," the "short pay-off" requirement, the "rate-of-return" requirement with variants or derivatives of them.

The engineering profession seems to be in agreement that a facility is replaceable when the lowest combined annual average of operating and capital cost of a replacement is less than the corresponding average of the old equipment when both averages are time-adjusted. A criticism of this minimum-average-cost method is that it ignores replacement obsolescence and service deterioration not reflected in operating cost. In order to allow for this omission some proponents of the method make an "adjustment" which is to reduce the length of service life and spread the capital cost over a shorter period. Since the shortened assumed period has no relationship to the actual service life, this modified device takes on the appearance of the short pay-off requirement. The computation in the short pay-off is accomplished in a variety of ways and usually means that the new facility shall "pay for itself" within two or three years. In a number of surveys, it was found that the pay-off periods were three years or less in two thirds of the cases. The writer labels this device as a drag on progress without justification or excuse, save for the advantage of convenience.

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[1] Executive Vice-President, New York Air Brake Co., Watertown, N. Y. Fellow ASME, Hon. Mem. ASME, ASME Medalist, 1943.

A less popular, but no less interesting, shortcut in replacement devices is the rate-of-return requirement, which is unlike the short pay-off in that the depreciation period is lengthened to ten years or longer and instead of using ordinary interest rates, the reckoning rate is increased to 15 per cent, and even higher. Mr. Terborgh characterizes this method a theoretical and practical monstrocity, correct only by chance and at best a dubious reliance.

Since these methods of replacement analysis are unworthy of continued acceptance by American industry, the author outlines the requisites of a sound policy which he has developed over many years by zealous application and endeavor. It requires a rational analysis for the comparison of mechanical options. The person who renders the decisions must be competent, must keep abreast of current developments in the field, and must have sufficient time to study the entire situation. Besides this a proper attitude toward justified re-equipment is required in order to minimize any advantage a competitor may secure through superior equipment.

The book develops justification for the acquirement of new facilities by explaining how functional, quantitative, and qualitative degradation acts with time and usage. His approach to replacement analysis begins with rented equipment, showing fallacies in certain procedures and applying his principles to long leases and comparing them with the alternatives of ownership by lease and the exchange of lease to ownership.

The intricate analysis of replacement is further considered by a complete analysis of future requirements, and the assumptions necessary where predictions become too theoretical. He advances his two standard assumptions, the first being based on his concept of the adverse minimum, and the second upon the concept of operating inferiority. The assumptions are then applied by means of a formula for replacement, the function of which is to test whether the old equipment shall yield to the new. In making these comparisons, he takes hypothetical cases with equipment having no-salvage and salvage value, with no future capital additions and with future capital additions, and those with both future salvage value and capital additions. He illustrates the derivation of his conclusions by means of tables and charts.

The book then introduces short-cut formulas for determining data in the above hypothetical cases. The author warns that these short-cut formulas rest squarely upon the assumptions and must be used with judgment and discrimination. In the use of the formulas, the symbols must be replaced by the actual figures in the problem at hand and this is where the difficulty enters—with all the uncertainties of the future.

The practical problems of estimation are then considered in the manipulation of the appropriate formulas for the particular situation. This last step is really the most difficult of all for it entails the compilation of the detailed data and estimates underlying the figures for their application.

The interest charge of borrowed and of equity money, the tax angle, and other effects upon replacement considerations are discussed. Many companies go along year after year making only replacements as their internally available funds provide and consequently live in a state of chronic undermechanization.

Following a discussion of the entire problem of replacement analysis, by proceeding from an abstract theoretical problem to the development of standard assumptions, a mathematical procedure is given for their application. Afterwards, the author leads to a simplification by a system of short-cut approximations followed by the estimating problems connected with these short cuts. He then offers a number of realistic situations by which one may apply the solutions sought for, warning that no standard method can be applied to the infinite variety and complexity of problems encountered in actual practice.

Nine different cases of straight replacement are considered in which the replacement is chosen only because it can better perform the job now being done. The cases cover a variety of establishments under varying conditions. Examples are also taken which involve replacement and expansion of capacity over a sufficient range to permit the analyst to make adaptations of his own. Illustrations are given in mathematical detail of various assumptions in both challenger and defender in an attempt to meet the analyst's problem in judging the acceptance or rejection of a course of action.

In a survey of almost two-hundred member companies of the Machinery Institute, it was found that only 28 per cent of the organizations have an equipment engineer who specializes in making replacement studies and only about 35 per cent of them make a regular, periodic review for purposes of improvement and modernization. Less than a third budget re-equipment expenditures in advance and almost two thirds the initial recommendations on improvement outlays came from superintendents, works managers, and department heads. The final decision in about the same proportion of cases was made by the president or other executive officer. So often, too, equipment salesmen are not permitted to bring their proposals to the officials with authority and when transmitted otherwise, effectiveness is impaired. Consequently, the result is often a haphazard, hit-or-miss procedure which fails to take advantage of available replacement opportunities.

"Dynamic Equipment Policy" is a work which has rereasoned the underlying theory of replacement practice and should be studied by all business executives, equipment engineers, and others responsible for re-equipment procedure. It is commended also for all those interested in the economic stability of American industry.

Historical Appraisal of Mechanics

A Historical Appraisal of Mechanics, Foreword by A. A. Potter. By Harvey F. Girvin. International Textbook Co., Scranton, Pa., 1948. Cloth, $5^{3}/_{4} \times 9$ in., 13 figs., bibliography, author and subject indexes, ix and 275 pp., $4.75.

Reviewed by R. S. Kirby,[2] Vineyard Haven, Mass.

THIS work by a Purdue professor is clearly and interestingly written. It is divided into three main sections: Part 1 (43 pp.) "The Creation of Science and Scientific Thinking;" Part 2 (108 pp.) "Scientific Thought Begins to Function;" Part 3 (90 pp.) "Mechanics of Materials;" which includes a chapter on "Mechanics and Engineering Education in the United States." No one can read this book without realizing the part played by the founding fathers in the development of the science of mechanics. In Part 2, Galileo's name appears at least once on 40 of the 108 pages; Newton's name on 36; doubtless this is as it should be. Professor Girvin devotes considerable space to a sketch of the life of Robert Hooke, and five pages to one of Thomas Young, not neglecting the latter's wife Eliza, "daughter of a cultivated and aristocratic family." If these are included, why omit so many others? This reviewer does not appreciate Harold J. Laski's pronouncement (p. 144) concerning the faith of those of us moderns who haven't altogether ruled out the supernatural; to him it seems completely irrelevant.

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[2] Associate Professor Emeritus of Engineering Drawing, Yale University.

The latter half of the book is devoted almost entirely to a thorough review of progress in the strength of materials field. Should not some attention have been paid to Bernoulli's basic investigations in hydrodynamics, and to recent developments in soil mechanics? Perhaps a later edition may include these. Professor Girvin, in a second edition, will of course correct some of the editing, which is careless in spots, specifically in the matter of names. Why write *Mdlle.* Germain and *Prof.* Church, *Prof.* Peck, etc.? And why *M.* Navier, *M.* Biot, etc. when these messieurs and half a dozen others all had at least one given name? Hiero II, the friend of Archimedes, was not King of Greece—nobody in those days was. The author will, we trust, rearrange the valuable 26 pages at the end of the book; at any rate the bibliography, with its alphabetically unhappy plan.

The style of the author is fresh and invigorating throughout, with hardly a dull page, and much quotable material. Especially unique and useful are the many compact tabulations showing what each scientist in his day contributed to mechanics, beginning with Archimedes. Both author and publishers are to be congratulated on the attractive typography. The work is in every respect a valuable and timely contribution to engineering history.

Combustion and Flame and Explosion Phenomena

THIRD SYMPOSIUM ON COMBUSTION AND FLAME AND EXPLOSION PHENOMENA. Published under the auspices of The Standing Committee on Combustion Symposia. The Williams and Wilkins Co., Baltimore, Md., 1949. Cloth, $6^1/_2 \times 10$ in.; tables, figs., illus., sketches, xiii and 748 pp., $13.50.

REVIEWED BY RAY E. BOLZ[3]

IN this volume are published, in full, the 100 papers presented at the Third Symposium on Combustion and Flame and Explosion Phenomena held at the University of Wisconsin, Sept. 7–11, 1948. This third symposium was initiated by Dr. Bernard Lewis, U. S. Bureau of Mines, and all research workers here and abroad in the related fields were invited to present significant findings made during the past decade. Over 400 persons attended the symposium, including about 30 from foreign countries which indicates the wide interest in the subject of combustion and flame.

The contents of this volume are divided into the following categories: (1) flame stabilization and quenching, (2) flame propagation and explosive gas mixtures, (3) flame of fuel jets, (4) ignition of gas mixtures, (5) kinetics and mechanism of combustion reactions, (6) flame spectroscopy, (7) burning and detonation of explosives, (8) thermodynamics of flame gases and thermochemistry, (9) experimental techniques, (10) combustion in engines and rockets, (11) gas burners and furnaces. This list indicates the great amount of experimental and theoretical work devoted to this subject that was stimulated to a great extent by the advent of jet engines, pulsejets, ramjets, and rockets during World War II.

Ten papers treat the subject of flame stabilization and quenching in steady-flow combustion. These papers deal with such investigations as the stability of gas-air flames burning from tubes and nozzles in laminar and turbulent flow, the mechanism of flame stabilization and flame propagation from bluff objects in fuel-air mixtures, the theory of stabilization of flames of nonturbulent gas mixtures, a study of the mechanism of flashback of aerated flames, and the structure of diffusion flames. The papers present a wealth of experimental knowledge concerning the phenomenon of stability of flames. The general agreement between experiment and theory for ***non-turbulent*** flames indicates that the theoretical models used describe the physical processes essentially correctly. The quantitative effect of turbulence on flame stability is as yet little understood and is thus a subject for continued intensive research.

The theory and experimentation concerning flame propagation in fuel-air mixtures is the subject of 19 papers. Attempts to isolate satisfactorily the individual effects of the variables affecting flame propagation by studying directly the operation of ramjet or turbojet combustion chambers have proved unsuccessful. Therefore, the experimenters have tried to devise certain experiments designed in such a way that one independent variable is primarily varied in a controlled manner. The rôle of turbulence in the flame propagation picture is, however, not quantitatively clear and it remains to be seen "whether the most significant contribution of turbulence is the increase of the transport rates of heat and chain carriers or since these transport rates remain comparable with those of laminar flow and the increased rate of flame propagation can be accounted for by increased flame surface resulting from turbulence."

The symposium papers on the subject of ignition approach the problem using a variety of ignition sources such as heated rods and wires, compression waves, capacitance and inductance sparks, etc. The papers present many interesting experimental correlations as, for example, between such parameters as source temperature and stream velocity between average electrical power and stream velocity, and between igniting current and frequency for successful ignition. The data, in general, indicate the effects of pressure, temperature, and fuel-air ratio on the ignition requirements of gas-air mixtures.

The great advances that have been made in the kinetics and mechanism of combustion reactions are presented in 21 papers. The oxidation of hydrocarbons is, of course, the subject of major effort in research and the work on reactions of the simple fuels such as hydrogen is attaining some degree of completeness.

The application of spectroscopy to combustion research is discussed in six papers in which spectroscopic methods are employed to determine local temperature measurements (such as the sodium line-reversal method) as well as to identify the appearance of certain radicals in the combustion processes in an attempt to interpret the chemistry in the combustion zone. Spectroscopy proves to be a very valuable tool and results in much information about the kinetics and thermodynamics of flames.

Only one paper appears on detonation in the general combustion engine indicating the very significant change of emphasis to the initiation and steady-state propagation of detonation waves in explosives as well as in gaseous fuel-air mixtures. The interest here extends into the details of the detonation process such as the pressure profile of the wave and the structure of the reaction zone.

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[3] Assistant Professor of Aeronautical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. Jun. ASME.

Some of the remaining papers deal with the calculation of the thermodynamic properties of gases from their spectroscopic data by machine-calculator methods as well as by hand methods. Soon the thermodynamic properties of hot gases and the corresponding equilibrium compositions will be available for almost any conceivable combination of fuel systems.

Still other of the remaining papers discuss experimental techniques for (1) measuring temperatures of exhaust gases by thermocouples, (2) measuring velocity and pressure of gases in flames, (3) interferometric gas analysis methods, (4) quantitative schlieren methods, (5) automatic gas sampling techniques, and (6) spray nozzle characteristics.

This volume is an extremely valuable contribution to the science of combustion because it brings together most of the significant problems and advances in the field and saves the individual researcher a vast amount of time that would otherwise be used in collecting such references from many remote sources. The book is beautifully printed and bound and should prove a model to other committees in other fields of scientific endeavor.

Outline of Surface-Type Heat-Exchanger Computation

DIE GRUNDLAGEN DER BERECHNUNG VON OBERFLÄCHEN-WÄRMEAUSTAUSCHERN. By Helmuth Kühne. Vandenhoeck und Ruprecht, Göttingen, Germany, 1949. Boards, $6^1/_2 \times 9^1/_2$ in., 12 tables, 4-9, inclusive, enclosed in envelope attached to back board; 40 figs., 32 plates. Bibliography, VIII and 192 pp., Dm 15.

REVIEWED BY MAX F. WULFINGHOFF[4]

THIS text presents a novel procedure in the computation of industrial exchangers. It represents a skillful and rigid application of dimensional analysis in accordance with the basic work on similarity laws in heat transfer by Nusselt and collaborators. The method holds for surface-type exchangers composed of flat or tubular elements with plain or extended surfaces, with fluids in controlled and steady flow, and for operation in a temperature range between —150 and + 1000 F, which permits of disregarding radiation effects. Following continental practice, which adds safety factors upon completion of calculations, no allowances for fouling and heat loss to ambience are made. Finally, no change of phase (by condensation or vaporization) is considered.

The book treats in succession types of exchangers, types of surfaces, physical properties of process materials, unilateral heat transfer relations, pressure drop relations, and mean temperature differences. A detailed explanation of Dr. Kühne's method of calculation is next followed by 40 numerical examples and a chapter on the testing of exchangers. The appendix presents 32 full-page plots, an itemized bibliography, author index, and subject index. Five large tables enable the user to rapidly determine coefficients and equations applying in the individual case and are contained in a folder in the back.

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[4] Engineer, Dresser Industries, Cincinnati, Ohio.

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Books Received in Library

AIRCRAFT STRUCTURES. By D. J. Peery. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, $6 \times 9^1/_4$ in., 566 pp., diagrams, charts, tables, $6.50. Written as an undergraduate text, this book presents a simple basic treatment of the subject with primary emphasis on fundamental structural theory, which will not change as new materials and new construction methods are developed. Especial emphasis is placed on the application of the elementary principles of mechanics to the analysis of aircraft structures. The problems of deflections and statically indeterminate structures are treated, and the topics of airload distribution and flight-loading conditions require a knowledge of aerodynamics.

DIE AUFBEREITUNG DER INDUSTRIE- UND GEBRAUCHS-WÄSSER. By R. Klein. Vulkan-Verlag, Dr. W. Classen, Essen Germany, 1949. Stiff cardboard, $6 \times 8^1/_2$ in., 487 pp., illus., diagrams, charts, tables, 28.60 Dm. Processes for the refining and improvement of water for industrial and commercial uses are described, with special attention to boiler feedwater. The first section discusses chemical and thermal treatments in detail. The second describes necessary equipment and provides design calculations.

FOUNDRY SCIENCE. By H. A. Schwartz. Pitman Publishing Corporation, New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, $6 \times 9^1/_4$ in., 286 pp., illus., diagrams, charts, tables, $6.50. Beginning with fundamentals of the properties of matter and energy, this text takes up successively the various important aspects of foundry practice. Although the emphasis is on the underlying chemical and physical principles, the treatment has been kept as simple as possible and a minimum of formal preparation in these subjects is assumed. A supplementary reading list is appended.

HEAT PUMPS AND THERMAL COMPRESSORS. By S. J. Davies. Constable & Company, Ltd., London, England, 1950. Cloth, $5^1/_4 \times 8$ in., 126 pp., illus., diagrams, charts, tables, 9s. The four lectures on which this book is based deal, respectively, with the following topics: fundamental heat-pump principles; vapor-compression heat pumps; heat pumps using air as working substance; thermal compressors with mechanical operation. Detailed examples are given of actual installations for space heating, space cooling, and air conditioning.

HYDROELECTRIC HANDBOOK. By W. P. Creager and J. D. Justin. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1950. Cloth, $6 \times 9^1/_4$ in., 1151 pp., illus., diagrams, charts, maps, tables, $12.50. This standard work gives a comprehensive and detailed treatment of the problems involved in hydroelectric power developments and provides sufficient data for preliminary designs, estimates of costs, and reports. The first of four major sections covers the investigation and planning of a hydroelectric project. The second section discusses and compares the various types of dams and presents the general design methods involved in their construction. Conduits and powerhouses are covered in the third section. In the final section, the mechanical and electrical equipment of a hydro plant and methods for its operation are dealt with. Owing to the extensive developments of the last twenty years, this second edition is considerably enlarged and has been largely rewritten.

INTRODUCTION TO INDUSTRIAL METALLURGY. By L. Aitchison. Macdonald & Evans, London, W.C.1, England, 1949. Cloth, $5^1/_2 \times 8^3/_4$ in., 456 pp., diagrams, charts, tables, 30s (available in America from the American agent, Edward W. Sweetman, 1 Broadway, New York 4, N. Y.). This book is intended to provide a complete picture of the structure, organization, operation, and control of a metallurgical plant. Emphasizing executive and management problems, it deals with both simple and complex production setups, supervision, personnel relations, plant layout, incentives, process and quality control, and the evaluation of productivity.

INTRODUCTION TO THE MECHANICS OF VISCOUS FLOW ("Streamline Flow"). By H. F. P. Purday. Dover Publications, New York, N. Y., 1949. Cloth, $5^1/_2 \times 8^1/_4$ in., 185 pp., diagrams, charts, tables, $2.75. First published in England under the title, "Streamline Flow," this book is an introduction to three closely related parts of physics: mechanics of nonturbulent flow; flow of heat by conduction; and heat transfer between solids and fluids in states of nonturbulent flow. The main object is to show by the simplest means how to calculate velocities, pressures, and boundary resistances arising in laminar fluid motion, and how to adapt these results to the theories of film lubrication and heat transfer.

LEGAL PHASES OF ENGINEERING. Contracts and Specifications. By I. C. Crawford. The Macmillan Company, New York, N. Y., 1950.

Cloth, $5^{1}/_{2} \times 8^{1}/_{2}$ in., 346 pp., tables, \$3.75. This textbook has three main objects: to acquaint the student with legal relations peculiar to the engineering profession and its daily business experiences; to promote an understanding of the process employed by the courts in arriving at a final decision; and to develop an appreciation of clear, concise contracts and specifications. Actual cases are used as illustrations.

Machine Tools for Engineers. By C. R. Hine. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, $6 \times 9^{1}/_{4}$ in., 355 pp., illus., diagrams, charts, tables, \$3.50. Based on courses developed at Rensselaer Polytechnic Institute, this book introduces the student to the fundamentals of machine tools and production processes. It gives a descriptive and analytical treatment of all types of machine tools, how they are used, what they can do, and what their limitations are. Some of the ways in which machine tools affect design of any product are discussed. The important machining processes are also covered.

Materials Handling Manual (III). Editors: M. M. Williamson and G. W. Williamson. Paul Elek (publishers), Ltd., London, England, 1949. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 364 pp., illus., diagrams, tables, 30s. This volume, as its predecessors, deals with aspects of handling applicable to all industries, with the exception that this edition is restricted to the handling of bulk materials, omitting package handling. All its sections have been brought up to date, and several new sections have been added, including a detailed treatment of underground materials-handling machinery. Both continuous movement (conveyers, elevators, pneumatic systems, etc.) and intermittent movement (earth-moving equipment, cranes, etc.) are covered.

Mathematical Theory of Communication. By C. E. Shannon and W. Weaver. University of Illinois Press, Urbana, Ill., 1949. Cloth, $6^{1}/_{4} \times 9^{1}/_{4}$ in., 117 pp., diagrams, charts, tables, \$2.50. The problem of transmission of information is dealt with from the standpoint of the probability of the reception of the message. Two main aspects are the mathematical determination of the accuracy of message transmission under varying conditions and the analysis of channel capacity. The concept of entropy is utilized in a specialized manner in dealing with certain statistical distributions. Of the two papers included, one was reprinted from *Bell System Technical Journal* of 1948. Of the other, a condensation appeared in *Scientific American*, 1949.

Mathematics Dictionary. Edited by G. James and R. C. James. D. Van Nostrand Company, Inc., Toronto, Canada; New York, N. Y.; London, England, 1949. Cloth, $6 \times 9^{1}/_{4}$ in., 432 pp., diagrams, tables, \$7.50. The earlier version of this dictionary covered terms in the range beginning with arithmetic and extending through the calculus. In the new edition basic terms have been added for metric differential geometry, theory of functions of real and complex variables, differential equations, theory of groups and of matrices, point-set topology, analytic mechanics, theory of potential, and statistics. Frequently used formulas appear in the context, and an appendix contains basic mathematical symbols and useful tables.

Mechanical Properties of Wood. By F. F. Wangaard. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1950. Cloth, $5^{1}/_{2} \times 8^{1}/_{2}$ in., 377 pp., illus., diagrams, charts, tables, \$6. A thoroughly revised version of G. A. Garratt's 1931 book of the same title, this volume provides information on the properties of more than 150 American woods as well as tables of basic-stress and working-stress values for structural species. The four parts treat: the basic mechanical properties of clear wood; factors affecting the mechanical properties; working stresses for structural lumber; and timber testing. References appear at the end of each section. The Appendix contains a sample plan for testing small clear specimens of wood.

Mechanical Wear, Proceedings of Conference held June, 1948, at Massachusetts Institute of Technology, Cambridge, Mass. Edited by J. T. Burwell, Jr. Published by American Society for Metals, Cleveland, Ohio, January, 1950. Cloth, $6 \times 9^{1}/_{4}$ in., 387 pp., illus., diagrams, charts, tables, \$6.50. Presenting different aspects of the wear phenomenon, this volume contains the papers and principal discussions presented at the M.I.T. Special Summer Conference on Mechanical Wear held in June, 1948. The papers cover laboratory and service experience on wear in internal-combustion engines, steam turbines, brake materials, journal bearings, gears, electric brushes, surface plates, and cutting tools. The effect of various factors on wear in any or all of the above types of services is also discussed.

Metallic Creep and Creep Resistant Alloys. By A. H. Sully. Interscience Publishers, New York, N. Y.; Butterworths Scientific Publications, London, England, 1949. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 278 pp., illus., diagrams, charts, tables, \$5.50. Presenting the viewpoints of both the practical engineer and the research metallurgist, this book describes the development of the existing theory of the strength of metals with special reference to creep. It also explains certain metallurgical factors affecting creep. A detailed summary of experimental techniques is also included as well as a survey of the creep properties of most of the well-known ferrous and nonferrous alloys. Speculations on future developments in creep-resisting alloys are made.

Nickel Alloy Steels. Second edition. International Nickel Co., Development and Research Division, New York, N. Y., 1949. Fabrikoid, $7^{1}/_{2} \times 9^{1}/_{4}$ in., paged in sections, illus., diagrams, charts, tables, gratis, limited distribution. This second edition revises and brings up to date pertinent data on nickel-alloy steels. The nine sections deal, respectively, with applications, wrought steels, cast steels, manufacture and processing, heat-treatment, special properties, stainless steels, iron-nickel and related alloys, and general information. It is published in loose-leaf form, as new data sheets and revisions will be issued as the need arises.

Oil Engine Manual. Fifth edition. By the editorial staff of *Oil Engine and Gas Turbine*, Temple Press, Ltd., London, E.C.1, England, 1950. Cloth, $5^{1}/_{2} \times 8^{1}/_{2}$ in., 334 pp., illus., diagrams, charts, tables, 15s. This volume is a complete reference book to oil engines of British manufacture for all industrial and land-transfer purposes. The first of three main parts gives the technical background of design for oil engines. Largely rewritten for this fifth edition, it contains new chapters dealing with operating costs and waste-heat utilization. Part two, now in the form of a buyer's guide, covers current models; and part three provides fundamentally important statistical items.

Punches and Dies, Layout, Construction, and Use. By F. A. Stanley. Fourth edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, $6 \times 9^{1}/_{4}$ in., 583 pp., illus. diagrams, charts, tables, \$4.75. This standard guide makes clear the practical fundamentals and shows the layout, construction, and various uses of punches and dies for specific types of work. In this fourth edition, several new types of dies are presented in detail, and there is an extensive rearrangement of the material. Another important topic covered is the use of press tools designed especially for stainless-steel piercing and blanking operations. In the metal-drawing field, the discussion of the manufacture of steel cartridge cases is expanded.

Railroads of Today. By S. K. Farrington, Jr. Coward-McCann, Inc., New York, N. Y., 1949. Cloth, $5^{1}/_{2} \times 8^{3}/_{4}$ in., 306 pp., illus., tables, \$6. New trains, new operations, and new mechanical developments are described. Among the railroads treated are six not included in the author's previous books on railroading. Centralized traffic control, new signal devices, new retarder hump yards, and track-inspection cars are given special attention. Separate chapters are devoted to brake development, bearings for high-speed freight service, and switch and signal installations. There is an unusually detailed index, and there are 72 pages of photographs of new trains in current operation.

Reibungstemperaturfelder in Turbulenten Grenzschichten. Zürich (Switzerland) Eidgenössische Technische Hochschule, Institut für Thermodynamik und Verbrennungsmotorenbau, Mitteilung No. 8. By K. Elser. Verlag Leemann, Zürich, Switzerland, 1949. Paper, $6^{3}/_{4} \times 9^{1}/_{2}$ in., 88 pp., diagrams, charts, tables, 9 Sw. fr. This report is devoted to a theoretical and experimental study of the question of heat transfer in swiftly flowing fluids and to the general problem of temperature zones which result from internal friction in the boundary layers of steady flows. A bibliography is included.

Scholarships, Fellowships, and Loans. By S. N. Feingold. Bellman Publishing Co., Boston, Mass., 1949. Cloth, $6^{3}/_{4} \times 9^{3}/_{4}$ in., 254 pp., \$6. The information given in this new reference book is listed alphabetically by administering agency with address, name of grant, qualifications, funds available, special fields of interest and information, and where to apply for information. In an introductory section the author discusses career planning and aids. The latter part of the book contains a bibliography, a subject index, and indexes of the administering agencies and names of grants.

Die Selbsttätige Regelung, theoretische Grundlagen mit praktischen Beispielen. By A. Leonhard. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1949. Paper and bound, $6^{1}/_{4} \times 9^{1}/_{2}$ in., 284 pp., diagrams, charts, tables; paper, 24 Dm; bound, 27 Dm. This book discusses the basic theoretical principles of automatic control as well as practical examples of its use. Following a chapter on fundamentals, the determination of a suitable control process is considered in detail. The stability of control is then inspected. The final chapter is devoted to methods for the determination of appropriate control constants. A bibliography is included.

Symposium on Metallography in Color (1948) (Special Technical Publication No. 86.) American Society for Testing Materials, Philadelphia, Pa., 1949. Paper and cloth, 6×9 in., 64 pp., illus., diagrams, charts, tables; paper, \$4.50; or cloth, \$5.15. This publication contains the latest practices for producing color reproductions of microstructures. The papers cover precautions necessary in specimen preparation, color of the illumination of the specimen, and the resulting color at the ground glass. Photographing metallic inclusions, the distinction by polarized light of intermetallic compounds, and delineation of the grains of alloys are also discussed. Ten plates with four-color process photomicrographs are included.

THERMODYNAMICS. (Oxford Engineering Science Series.) By E. Schmidt, authorized translation from the third German edition by J. Kestin. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1949. Cloth, $6 \times 9^1/_2$ in., 542 pp., illus., diagrams, charts, tables, $7. Written primarily for mechanical-engineering students, this book covers the theory of thermodynamics and gives many examples of the application of the theory to practical problems. It is an English translation of the third German edition but contains, in addition, a chapter on jet and rocket propulsion, and the discussion of gas and steam turbines is extended to include up-to-date methods. The most recent data available have been used in the numerical tables and in calculations.

WELDING HANDBOOK. American Welding Society, compiler and publisher, New York, N. Y. Third edition, 1950. Cloth, $6 \times 9^1/_4$ in., 1651 pp., illus., diagrams, charts, tables, $12 in U. S. and Canada, $13 elsewhere. This standard Handbook contains sixty-five chapters covering the more than thirty welding and cutting processes used by industry today, the welding of ferrous and nonferrous metals and alloys, and the application of welding in different industries. Also included are individual chapters on cost estimating, welding metallurgy, physics of welding, a dictionary of welding terms, general engineering tables, welding symbols, and inspection methods. A bibliography at the end of each chapter lists important codes, standards, books, and technical articles. A detailed 69-page index provides ready access to the material.

ASME BOILER CODE

Proposed Revisions and Addenda to Boiler Construction Code

As need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code, to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennally the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [ ]. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

PAR. P-291 Water Glasses. Revise first section as follows:

Each boiler shall have at least one water gage glass except that boilers operated at pressures over 400 psi shall be provided with two water gage glasses which may be connected to a single water column, or connected directly to the drum. The gage glass connections and pipe connections shall be not less than $^1/_2$ in. pipe size. [Each water gage glass shall be equipped with a valved drain]. EACH WATER GAGE GLASS SHALL BE FITTED WITH A DRAIN COCK OR VALVE. WHEN THE BOILER OPERATING PRESSURE EXCEEDS 100 PSI, THE GLASS SHALL BE FITTED WITH A GLOBE OR GATE-VALVED DRAIN TO THE ASH-PIT OR OTHER SAFE DISCHARGE POINT.

PAR. H-87 Washout Openings. Revise as follows:

All cast-iron steam and hot-water boilers shall be provided with suitable washout openings to permit the removal of any sediment that may accumulate therein. Washout openings may be used for return pipe connections and the washout plug placed in a tee so that the plug is directly opposite and as close as possible to the opening in the boiler. THIS IS NOT TO BE CONSTRUED AS REQUIRING WASHOUT OPENINGS AT BOTH ENDS OF THE BOILER.

PARS. H-39 and H-92. Revise first sentence, second section as follows:

If the system is equipped with an open expansion tank, an [internal] INDOOR overflow from the upper portion of the expansion tank must be provided in addition to an open vent, the [internal] INDOOR overflow to be carried within the building to a suitable plumbing fixture or to the basement.

PARS. H-64(b) and H-117(b). Delete and reletter succeeding paragraphs.

PAR. H-118 Revise as follows:

All hot-water heating or hot-water supply boilers marked for working pressures not over 30 psi, and steam-heating boilers, shall be subjected to a hydrostatic test of NOT LESS THAN 60 psi at the shop where made, on each individual section. Hot-water heating and hot-water supply boilers marked for working pressures over 30 psi shall be subjected to a hydrostatic test of $2^1/_2$ times the maximum allowable working pressure [both] at the shop where made, on each individual section. [and in the field when erected and ready for service]. HOT-WATER HEATING AND HOT-WATER SUPPLY BOILERS MARKED FOR WORKING PRESSURES OVER 40 PSI SHALL BE SUBJECTED TO A HYDROSTATIC TEST OF $1^1/_2$ TIMES THE MAXIMUM ALLOWABLE WORKING PRESSURE IN THE FIELD WHEN ERECTED AND READY FOR SERVICE.

Any hydrostatic pressure test to be made on either a steam-heating boiler or hot-water boiler, after the boiler has been in service, shall be at a pressure of $1^1/_2$ times the maximum allowable working pressure.

In making hydrostatic pressure tests IN THE FIELD, the pressure shall be under such control that in no case shall the required test pressure be exceeded by more than 10 psi.

PAR. P-103(a) Material. Revise to read:

The materials used in the fabrication of any fusion-welded drum, shell, pipe, or parts covered by this Code shall conform to Specifications SA-27, SA-30, SA-31, SA-53, SA-72, SA-83, SA-84, SA-105, SA-106, SA-129, SA-135, SA-157, SA-158, SA-178, SA-181, SA-182, SA-192, SA-201, SA-202 Grade A, SA-203, SA-204, SA-206, SA-209, SA-210, SA-212, SA-213, SA-216, SA-217, SA-225, SA-240, SA-249, Grades TP304, TP321, TP347, TP316, SA-250, SA-266, SA-280, SA-285, SA-299, SA-301, or SA-302. The carbon content in such Materials shall not exceed 0.35 per cent AND OPEN HEARTH OR ELECTRIC FURNACE STEEL SHALL BE USED FOR THE FUSION WELDED DRUM OR SHELL.

PAR. P-300, Revise item (4) as follows:

Expanding into grooved holes, seal welding if desired. PIPE WHICH IS EXPANDED, ROLLED, OR PEENED SHALL BE MADE FROM OPEN HEARTH OR ELECTRIC FURNACE STEEL.

Table P-5 Revise Note 3, as follows:

These stresses SHALL BE permitted FOR OPEN-HEARTH AND ELECTRIC-FURNACE STEEL only if 0.10 per cent minimum silicon CONTENT is expressly specified.

Table P-7 Revise Note 3, as follows:

These stresses SHALL BE permitted FOR OPEN-HEARTH AND ELECTRIC-FURNACE STEEL only if 0.10 per cent minimum silicon CONTENT is expressly specified.

PAR. Q-101 In footnote 3, fourth line, change title of Specification SA-233 as follows: . . . . . for [Iron and Steel] MILD STEEL Arc-Welding Electrodes.

Tables P-7 and U-2 Opposite Specification SA-182, Grade F8m, change the 1150 F stress to "5300" and the 1200 F to "4000."

Erratum

PAR. U-77(b) The revision printed in the March, 1950, issue of MECHANICAL ENGINEERING should have been added to the end of the first sentence without deleting "if such a test is feasible."

Announcement

Part UCL, Code for Unfired Pressure Vessels, Section VIII, 1950, "Supplementary Requirements for Welded Pressure Vessels of Integrally Bonded Clad Plate and Those Having Applied Corrosion-Resistant Linings," dated February, 1950, and formerly Appendix III of Minutes of March 10, 1950, has been approved as part of this Section.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Record Attendance at SAM-ASME Time-Study and Methods Conference

FUNDAMENTAL problems facing management, such as: What is a fair day's work? how to determine the work load? how to improve indirect work? and others, attracted some 1200 industrial engineers and time-study men to the Fifth Annual Time Study and Methods Conference held at the Hotel Statler, New York, N. Y., April 20-21, 1950. The conference was sponsored by The Society for the Advancement of Management with the co-operation of the Management Division of The American Society of Mechanical Engineers.

At the first luncheon, H. H. Whitmore, treasurer and general manager, Jones and Lamson Tool Company, defined a work standard as a "predetermined and accepted model against which the effort of an individual or group of individuals may be compared in order to establish the effectiveness of the individual or group being studied."

Work standards, he said, are helpful in guiding policy decisions of top management, especially at the present time when enterprises are being squeezed between the demand by workers for greater benefits and the demand by consumers for lower prices.

Work Standard to Be Available Soon

At a crowded session preceding the luncheon, Herbert A. Lynch, Jr., of New York University, reported that a nationwide standard of operation performance on a variety of simple manual operations recorded on motion-picture film would be completed soon. The film, according to Mr. Lynch, would enable a company to compare its concept of proper performance with the composite concept of a large number of time-study engineers. It would provide an objective standard for reference in disputes about accuracy of specific time standards and could also be used to train or retrain time-study engineers, union officials, and members of management. The films have already been viewed and rated by 1100 industrial engineers and time-study men in more than 150 companies.

Application of incentives to maintenance and other indirect work was discussed by Herbert J. Moore of Swift and Company. Commenting on his company's long experience with incentives for maintenance workers, Mr. Moore warned that economies in maintenance costs are not easy to prove to skeptical master mechanics whose support is essential. He described a plan which has been in use since 1926. It is no panacea, he said, but their experience with it has been generally good.

Mechanization is not eliminating skill as a requirement of the worker but is substituting intellectual for manual skill, according to Peter Drucker, industrial economist, who addressed the dinner, the social high light of the conference.

Modern Industry Needs Higher Skills

What has happened, Mr. Drucker said, is that the intellectual skills of the designer, the engineer, the foreman, the time-motions man, and the hundreds of other trained men are taking the place of the manual skill of the craftsman. Since learning and understanding have always been considered higher forms of skill than manual skill, modern industrial production calls for infinitely more skill than any other system of production.

The industrial engineer looks upon the human being as a tool who works most efficiently when his work is set up and laid out for him. The social scientist, on the other hand, feels that men must participate in decisions about their work if they are to be most productive. Neither the concept of the engineer nor the scientist is the whole truth. This lies in a combination of the two which occurs when scientific management is applied to the group rather than the individual. With the group concept the engineer can set time and basic methods and yet grant the individual considerable latitude to organize the work in his own way.

Long View on Engineering Employment Bright

EXCEPTION was taken recently by Clement J. Freund, Fellow ASME, dean, College of Engineering, University of Detroit, Detroit, Mich., to the flood of predictions that engineering employment will be a major problem in the engineering profession for some time to come. Speaking before a meeting of the American Society for Engineering Education held recently at Swarthmore College, Dean Freund said he was convinced that the engineering profession was as much in its infancy today as the automobile industry was in the days when Henry Ford announced the Model T.

"Although engineering seniors who expect to graduate this year may have a temporary employment difficulty, I am convinced that in the long run, employment opportunities in engineering will continue to be good.

"We talk about saturation in engineering employment. What we mean is possible saturation in a dozen industries," he said.

"Engineers have restricted their thinking and planning too much to a few typical engineering industries, such as utilities, automobile, and electrical-equipment manufacturing and chemicals; and to a few typical engineering functions such as design, development, and sales.

"We have neglected important types of engineering jobs. How many who have graduated since the war have gone into plant engineering or master-mechanics' departments or into production control? Or into customers' service or shop management? Or inspection or quality control?

"We must enlarge our outlook to discover a shortage in other fields of engineering graduates and not stay frozen to traditional modes of thinking."

AEC Withholding Little Information From Industry

TECHNOLOGICAL information uncovered in atomic-energy research and of potential interest to American industry is being declassified on a fairly satisfactory basis according to the preliminary conclusions of a technological working party which has been searching the abstract file maintained by the Patent Branch of the Atomic Energy Commission.

Members of the working party, representing technical and engineering societies and the business press, were given complete security investigation and clearance to enable them to enter restricted areas and to examine restricted information files. S. A. Tucker, ASME staff, represented The American Society of Mechanical Engineers on the working party. (See February issue of Mechanical Engineering, page 182.)

Following its work with the patent abstract files, the working party has expressed willingness to continue work on the AEC's trial program to make atomic-energy information more readily available to industry.

To accomplish this the AEC has authorized an expansion of the scope of the test program to include a study of the technology of electromagnetic separation which has been carried on primarily at the Y-12 installation at Oak Ridge, Tenn. This is not immediately and directly related to the present weapons operations in the national atomic-energy program.

The working party will have an opportunity to evaluate technology developed in connection with the electromagnetic separation process, with the exception of production data bearing on capacities and enrichments in the process.

Members of the group will scrutinize applicable individual technical reports on processing and operations of the Y-12 plant; inspect the electromagnetic separation plant operations; and examine plant technology with the aid of engineering and technical personnel.

In searching the patent abstracts, members of the working party reviewed a sample of approximately 800 abstract files. On the basis of this examination the group concluded:

1 That the declassification of technological information through the normal declassification routine is proceeding fairly satisfactorily, but that some classified patent applications of industrial interest should be submitted for declassification.

2 That there appears to be in the fields specified for study by the working group in the files of the Patent Branch, no great store of unclassified or clearly declassifiable technological information which has not been declassified and which would be of great usefulness to American industry.

3 That further review of the classified files of the Patent Branch by the working party would not be profitable, since the sample already scrutinized by the working party has revealed that relatively little technology of major importance is being withheld.

4 That the search of the patent files was of sufficient interest to warrant continuing the test program, especially to study the complete technology of a major atomic-energy process, such as that being carried on at Y-12.

New Commission on Latin America Named by EJC

L. J. HUGHLETT, Mem. ASME, was appointed chairman of the Engineers Joint Council's Commission on Latin America and authorized to appoint as many as eleven other members to aid him in carrying out specific tasks. This action was taken at the meeting of the Committee on International Relations of the Engineers Joint Council held on April 27, 1950, in New York, N. Y.

Among the tasks facing the Commission are: (1) Analysis of the constitution of UPADI (Union of Pan-American Engineering Associations) drafted at the first Pan-American Congress held in Rio de Janeiro, in July, 1949; (2) to study ways to provide financial support for UPADI; (3) organization of American participation in the Havana meeting planned for late 1950; (4) invitation to UPADI to participate in the 1952 Centennial of the American Society of Civil Engineers, and (5) drafting of a statement defining degree of co-operation which American engineers can give to UPADI.

In another action the Committee on International Relations appointed S. E. Reimel, Mem. ASME, as the permanent EJC liaison representative to the Economic and Social Council of the United Nations. EJC was asked to name such a representative because of its inclusion in a special register of organizations which can contribute substantially to the work of the United Nations.

In order to co-ordinate the work of the American Society for Engineering Education and the EJC in the field of international relations as it affects visits of foreign engineers to the United States, the EJC has invited ASEE to send a representative to the meetings of the EJC Committee on International Relations.

EJC is also co-operating with the Institute of International Education which is overseeing, under the auspices of the Economic Cooperation Administration, the training of 30 British graduate engineers with ten years' experience, who are in this country taking special courses. These men want employment with or without remuneration for periods of three months to one year in large American industries. While the task of finding such employment would be difficult, members of the Committee agreed to consider the matter and to offer suggestions at a later date.

West Coast Group Holding Seminars on Hydraulics

NEW interest in the application of hydraulics to problems of industry has been stimulated on the West Coast during the past year by the activities of the Committee on Hydraulics and Pneumatic Systems sponsored by the Hydraulics, Applied Mechanics, Industrial Instruments and Regulators, and Aviation Divisions of the Southern California Section of The American Society of Mechanical Engineers in co-operation with the local sections of several national engineering societies.

The Committee was organized in December, 1948, by Anthony Hunter, Mem. ASME, and Peter Kyropoulos, Mem. ASME, both directors of the Hydraulics Division of the ASME Southern California Section, for the purpose of providing a program for engineers working in hydraulics. To cover the subject properly, the local sections of the following societies were invited and joined in the work of the Committee: American Society of Civil Engineers, American Institute of Electrical Engineers, Institute of the Aeronautical Sciences, Society of Automotive Engineers, and the American Rocket Society.

The Committee is conducting a series of seminars on basic theory and application of hydraulics to specific industries, and is working on a manual of recommended practices for selection, design, development, and testing of hydraulic and pneumatic operating and control systems.

Johannes S. Newton, Jun. ASME, research analyst, North American Aviation Inc., Los Angeles, Calif., is chairman of the Committee.

World Engineering Group Studied at Paris

THE Advisory Committee on Engineering Organization of UNESCO (United Nations Educational, Scientific, and Cultural Organization) held a meeting in Paris, France, March 6–9, 1950, to explore the possibilities of better international organization of engineers and engineering societies.

Engineers from Switzerland, The Netherlands, France, Italy, England, India, Sweden, and the United States were present. William N. Carey, secretary, American Society of Civil Engineers, attended the meeting as a representative of the Engineers Joint Council. The Advisory Committee concluded that UNESCO should aid the formation of a co-ordinating federation of engineering organizations of one type only, and this to be of organizations formed on a horizontal basis such as the World Power Conference, the International Conference on Irrigation, and others. This conclusion was in accordance with views expressed at the last London Conference. (See November, 1949, issue of Mechanical Engineering, page 955.)

The Committee also developed a draft of a constitution to be placed before a proposed meeting of 15 horizontal-type organizations, to be held in Paris, France, in September, 1950, under the sponsorship of UNESCO, for the purpose of organizing an international collaborative engineering group.

Variety of Products to Be Seen at Power Show

PRELIMINARY analysis of the exhibits already planned for the 1950 National Power Show indicates that a wide variety of products will be represented. These will include interesting displays of boilers, stokers, steam engines, compressors, condensers, cooling towers, power oil burners, pumps, fans, blowers, coal and ash-handling equipment, dust collectors, oil purifiers, internal-combustion engines, valves, piping, fittings, control instruments, refractories, insulation, metals, steam specialties, boiler tubes, motors, switches, controls, pulleys, gears, speed changers, chains, belting, bearings, clutches, industrial trucks, hoists, conveyers, lubricants and lubrication systems, scales, packing, gaskets, water treatment, timers, pipe-threading machines and other tools, plus innumerable other products important in the power field.

Officially known as the 19th National Exposition of Power and Mechanical Engineering, the exposition will be held under the auspices of The American Society of Mechanical Engineers, whose Annual Meeting will be held in New York, N. Y., during the same week. This year the exposition will be held in the Grand Central Palace, New York, N. Y., Nov. 27–Dec. 2. The exposition is managed by International Exposition Company with permanent headquarters at Grand Central Palace, New York, N. Y.

Government Reports

A NEW guide to the Government's collection of wartime and postwar technical-research reports was recently announced by the Office of Technical Services, U. S. Department of Commerce, Washington, D. C. It is "The Numerical Index to the Bibliography of Scientific and Industrial Reports" (volumes 1–10, 1946–1948) published by the Special Libraries Association, 31 East 10th Street, New York 3, N. Y. Price is $10.

Interesting Symposium Planned for ASTM 1950 Annual Meeting

ENGINEERS interested in gas-turbine materials, the effect of sigma phase on high-temperature metal properties, nondestructive testing in production, and other materials problems, should find much new information at the symposiums planned for the 1950 annual meeting of the American Society for Testing Materials to be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., June 26–30, 1950.

Corrosion and erosion of gas-turbine materials will be the topic at a symposium at which important investigations on corrosion of various types of materials used in the gas turbine will be reported. Two of the papers will comment on coal and oil ash corrosion, while others will deal with such topics as surface as a limiting factor in creep, effect of environment on the stress-rupture properties of metals, stress-corrosion tests on turbosupercharger materials, and hydrogenizing reactions of gases on metals at elevated temperatures.

Effect of Temperature on Metals

The effect of sigma phase in the high-temperature properties of metals will be discussed in a two-session symposium sponsored by the Research Panel of the ASTM-ASME Joint Committee on Effect of Temperature on Properties of Metals. The symposium will take up: (1) Structure and impact resistance of columbium-bearing 18–8 steels; (2) the formation of sigma and its influence on the behavior of stabilized 18–8 Cr-Ni steels in concentrated nitric acid; (3) observations of the effect of sigma on the mechanical properties of columbium stabilized weldments in austenite stainless steels; (4) x-ray study of the sigma phase in various alloy systems; (5) sigma phase in chromium-molybdenum alloys with iron or nickel; (6) identification and mode of formation and re-solution of sigma phase in austenitic Fe-Cr-Ni steels; (7) sigma phase in several cast austenitic steels; (8) effect of prolonged exposure at elevated temperatures on the microstructure and mechanical properties of AISI type 310 stainless steel; (9) formation of sigma phase in 17 Cr steel; and (10) occurrence of sigma phase and its effect on certain properties of cast Fe-Ni-Cr alloys abstract.

In addition to the formal symposiums, two technical sessions will include a series of papers covering the properties of ferrous and nonferrous metals at elevated temperatures. Subjects in these sessions, which are on the mornings of June 28 and 29, include: Effect of treatments on fatigue strength of alloys up to 1200 F; interpretation of high-temperature alloy stress-rupture data; hardened alloy steel for service up to 700 F; mechanical properties of austenitic stainless steels; hardening of austenitic steels by mechanical working at subzero temperatures; and discussion of chromium-base alloys.

Nondestructive Testing

The ASTM Committee E-7 on Nondestructive Testing will offer the latest information on the following topics: Management's choice of nondestructive tests; some defects or discontinuities that can be revealed in cast and wrought-metal products by nondestructive tests; economics of castings, weldment, wrought-steel inspection, and special inspection problems.

A feature of the meeting will be an exhibit of testing apparatus and related equipment by leading manufacturers and distributors of instruments and laboratory supplies.

IPE Scholarship Winners to Study in American Plants

TWO young British engineers, B. E. Stokes of Birmingham, and W. N. Aspinall of Rugby, winners of the 1950 Schofield Travel Scholarships awarded by the Institution of Production Engineers, will soon be in the United States studying American production techniques in the plants of four American companies who are co-operating with the Institution. The young men were selected from a panel of seven finalists who were subjected to a two-day interview. The selection committee questioned candidates in private interviews and observed their reactions to various situations during an informal after-dinner program at which broad engineering topics were offered for discussion.

Mr. Stokes plans to study industrial administrative structures with reference to increased productivity and uses of production control. Mr. Aspinall intends to specialize in application of welding to construction of large components with reference to reduction of cost by control of distortion and premachining of materials. Each of these winners will receive a total of six months' practical training in the following American plants: Kearney and Treaker Corporation, Milwaukee, Wis.; Black and Decker Manufacturing Company, Towson, Md.; Ranco, Incorporated, Columbus, Ohio; and plants of the Western Electric Company.

New Engineering Curriculum Proposed

A NEW way of educating engineers was advocated recently by A. F. Taggart, professor, Columbia University, before the annual meeting of the American Institute of Mining and Metallurgical Engineers. Excerpts from Professor Taggart's talk were published in the April issue of *Mining Engineering*.

Professor Taggart finds fault with the traditional divisions of engineering by calling these "improper fragmentations" of empirical engineering knowledge. Instead of the current "wrappings" he advocates teaching engineering under headings which cut across traditional departmental boundaries.

He points out that the attitude of industry is to defer imposition of responsibility on engineering graduates until they are apprenticed for periods of months to years to teach them details of the company's business. By changing the curriculum, men could be equipped to complete such apprenticeship quickly and thereby derive maximum benefit from a four-year curriculum stripped of repetitiousness and operating detail.

The curriculum advocated for all engineering students consists of five divisions, in each of which the subject matter is designed to give a broad basic engineering training. These divisions are:

1 *Human Relations:* Specific subject matter offered under this heading is to be elementary biology and the humanities, political and economic history, and English.

2 *Science:* This department is to be given major weight and consideration of a four-year stretch of physics, chemistry, and mathematics, completely integrated and intermingled.

3 *Basic Engineering:* Under this division the subject matter would consist of properties of solids, properties of fluids, static structures and machine elements, energy transformations, and instrumentation.

4 *Specialty Subjects:* This division would consist of 10 semester points in the senior year devoted to application of engineering principles to some specialty.

5 *Graduate Work:* Professor Taggart feels the only justification for advanced study is to train for research. This division would be open to those graduates who possess the special qualifications of a research worker.

Commenting on Professor Taggart's proposed curriculum, Curtis L. Wilson, a member of the ECPD Committee on Engineering Schools, said, "This curriculum would be turned down by the ECPD Committee on Engineering Schools. It is not engineering."

Conference Reviews Status of Automatic Computers

FAILURE of designers and engineers to provide a large-scale electronic digital computer at a price which institutions and industrial research laboratories could afford to pay was deplored by H. H. Aiken, head of the Harvard University Computation Laboratory, at a recent conference on automatic-computing machinery held at Rutgers University, New Brunswick, N. J., March 27–29, 1950. More than 350 engineers and executives participated in the three-day program during which they heard ways of reducing automatic-computer costs and had an opportunity to inspect seven small, moderately-priced computers. One of these was the "Maddida" built by the Northrup Aircraft, Inc., Hawthorne, Calif., and recently declassified by the Armed Services. This machine occupied as much space as a pinball machine and was able to handle 4500 additions of eight-place decimal numbers per second and could produce answers accurate to 1 part in a million. The machine has 56 tubes not including power supply and readout. It sells for $25,000.

Perry Crawford, of the Research and Development Board, told the engineers that computers have reduced the cost of solving problems about 35 times in the last decade, indicating that a problem which ten years ago would cost ten dollars to compute, now can be done for about 30 cents.

James L. McPherson, Bureau of the Census, said that the Bureau has on order computers which will allow the agency to secure information 400 times faster than with present methods.

In characterizing present work-computing devices, Professor Aiken said that three main objectives are being sought: (1) The design of devices for storage of information; (2) faster and still faster computing means; and (3) more logical code arrangements. He said that while computers of moderate cost can be built, no machine with a capacity of 1000 ten decimal digits, a storage capacity of 1000 code commands, suitable sequencing controls, with two output typewriters and four input-output mechanisms using magnetic tape, using less than 100 feet of floor space, and costing less than $5000 has yet emerged.

Newest Tools Displayed at ASTE Exposition

1950 ASTE Officers Announced

YANKEE ingenuity as it expresses itself in the toolrooms of American metal-working industry was on display during the Industrial, Cost-Cutting Exposition of The American Society of Tool Engineers held in Philadelphia, Pa., April 10–14, 1950.

While some 300 exhibitors were busy demonstrating applications of tool engineering to make possible new economies in die costs, time required to change dies, sheet-metal fabrication, and other operations, a technical program was attracting audiences for papers on such topics as machinability of metals, cold-roll forming, automation, broaching applications for cost reduction, and others.

It was evident at the exposition that automation, the automatic handling of parts in production without physical effort by the operator, was held by many engineers as being the greatest immediate promise for cost reduction by industry. N. L. Bean, Mem. ASME, The Ford Motor Company, told how his company was producing three million bushings a month on an "automatized" production line in which the bushings were touched by hand only once. He said that even this single manual operation would soon be automatized.

Among the exhibits which attracted attention was a new multiple-spindle drill press on which up to five spindles can be used in any position from 3 to 7$^1/_2$ in. apart; a tool grinder that could be used as a surface grinder, a chip-breaker grinder, a universal tool and cutter grinder; various remote-control timing devices which convey and classify work in process and do it automatically; magnetic holding fixtures for milling and other machines; surface plates made of noncorrosive nonmagnetic ceramic materials which were reported to reduce wear on gages and increase bluing speed; light-wave micrometers, stereoscopic microscopes, and others.

At the annual meeting of the ASTE, election of the following officers for 1950 were announced: ***President***, Herbert L. Tiggs, vice-president, Baker Brothers, Toledo, Ohio; ***first vice-president***, J. J. Demuth, methods engineer and general superintendent, Sligo Iron Works, St. Louis, Mo.; ***second vice-president***, H. E. Collins, Hughes Tool Company, Houston, Texas; ***third vice-president***, Roger F. Waindle, Elgin National Watch Company, Aurora, Ill. W. B. McClellan was re-elected secretary and George A. Goodwin, treasurer.

Salesmanship for Engineers

TO RELIEVE the extreme shortage of engineers in sales work, the College of the City of New York is offering a course called "Salesmanship for Engineers" consisting of 300 hours of instruction. One half of the course is devoted to the techniques of salesmanship which include such selling skills as the approach, demonstrating, meeting objections, and handling the interview. Sixty hours are to be given up to practicing speech in selling, 30 hours to a survey of industrial marketing, and the last 60 hours to market analysis, advertising, and marketing problems affecting the industrial engineer. For further information, write to City College Midtown Business Center, 430 West 50th Street, New York 19, N. Y.

World-Wide Heat-Transfer Discussions Planned for 1951

POSTWAR heat-transfer development will be the theme of international discussions to be held in London, Sept. 11–13, 1951.

Plans for participation by engineers in the Western Hemisphere are being arranged by the Joint Committee on North American Participation, which consists of representatives from The American Mathematical Society, American Institute of Chemical Engineers, American Chemical Society, The American Society of Refrigerating Engineers, American Society of Heating and Ventilating Engineers, The American Society of Mechanical Engineers, American Institute of Physics, American Institute of Mining and Metallurgical Engineers, The American Physical Society, The Society of Automotive Engineers, The Institute of the Aeronautical Sciences, and The Engineering Institute of Canada.

Arrangements for American participation are being handled by the ASME. Participation by British and European engineers is being co-ordinated by The Institution of Mechanical Engineers with the co-operation of 30 British societies and the engineering and technical societies of Australia, India, New Zealand, South Africa, Belgium, Denmark, France, Holland, Norway, Sweden, and Switzerland.

Preliminary plans indicate that the following subjects will be among those discussed: Recent information on physical properties of gases and gas mixtures pertinent to their heat-transfer characteristics, measurement problems related to heat transfer, mass transfer and heat transfer, heat transfer by sweat and film cooling, condensation at high-speed flow, heat transfer to liquid metals, analogy method for the solution of conduction problems.

Meetings of Other Societies

June 12–16
American Institute of Electrical Engineers, summer meeting, Huntingdon Hotel, Pasadena, Calif.

June 19–23
American Society for Engineering Education, annual meeting, Seattle, Wash.

June 19–24
American Association for the Advancement of Science, Pacific division meeting, Salt Lake City, Utah

June 26–30
American Society for Testing Materials, 53rd annual meeting, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

June 26–30
American Petroleum Institute, division of production, midyear standardization committee conference, Brown Palace Hotel, Denver, Colo.

July 12–14
Engineering Institute of Canada-American Society of Civil Engineers, joint summer convention, Royal York Hotel, Toronto, Ont., Can.

(For ASME Calendar of Coming Events see page 529)

Notes on Coming Meetings

THE Institute of Petroleum will sponsor the second Oil Shale and Cannel Coal Conference at the Royal Technical College, Glasgow, Scotland, July 3–7, 1950.

The Conference will have three main divisions: (1) Geology and mining; (2) retorting, refining, and uses of by-products; and (3) economics and statistics. In addition to technical sessions there will be a tour of Scottish shale fields and the shale works of the Scottish Oils, Limited. Further information may be obtained from the Secretary, The Institute of Petroleum, 26, Portland Place, London, W. 1, England.

Heat Transfer

PAPERS on such subjects as nonisothermal turbulent flow with variable fluid properties, statistical analysis of turbulent flow, combustion stability, and other topics, will be presented at the 1950 Heat Transfer and Fluid

Mechanics Institute to be sponsored by five California universities and a number of California sections of national societies to be held at the Institute of the Aeronautical Sciences Building, Los Angeles, Calif., June 28–30, 1950. The Applied Mechanics, Heat Transfer, and Hydraulics Divisions of The American Society of Mechanical Engineers are co-operating in the Institute. For details of the program, write to 1950 Heat Transfer and Fluid Mechanics Institute, 3076 Engineering Building, University of California, Los Angeles 24, Calif.

Education

TWO conferences and a dinner are being sponsored by the mechanical-engineering section of the American Society for Engineering Education at the ASEE 58th annual meeting to be held at the University of Washington, Seattle, Wash., June 19–23, 1950.

The first conference is scheduled for Monday, June 19, and will be a panel discussion on instrumentation and its instruction. Formal statements will be presented by C. F. Kayan, Mem. ASME, Columbia University; F. L. Schwartz, Mem. ASME, University of Michigan; H. L. Mason, Mem. ASME, Iowa State College; and E. F. Obert, Mem. ASME, Northwestern University.

The second conference will concern itself with machine design and manufacturing. The scheduled speakers will be J. Heuschkel, Westinghouse Electric Corporation; V. L. Malley, Oklahoma A.&M. College; and S. E. Rusinoff, Mem. ASME, Illinois Institute of Technology.

Wilson Compton, Washington State College, will address the mechanical-engineering section dinner on Wednesday, June 21. His subject will be "Big Science, Big Business, and Big Government."

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THE ASEE mechanics-division summer school will be held at Iowa State College, Ames, Iowa, Sept. 11–15, 1950. The theme will be "Dynamic Teaching of Engineering Mechanics."

Engineering Literature

FOUR American Standards were recently published by The American Society of Mechanical Engineers. Copies may be obtained from ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Railroad Symbols

American Standard Graphical Symbols for Railroad Use, ASA Z32.2.5–1950: This is the fifth in a group of standards currently being developed to supersede and expand the 1941 American Standard Graphical Symbols for Use on Drawings. The 18-page standard is a compilation and correlation of symbols used by engineering and signal divisions of various American railroads. While some of the symbols conflict with those shown in other American standards, the drafting committee felt that the new standard will cause no confusion. Better correlation is expected to come about gradually through subsequent revisions. Price is 75 cents.

Bolts

The American Standard High-Strength High-Temperature Internal Wrenching Bolts, ASA B18.8–1950: The standard is intended for use in high-strength applications, such as steam-turbine work, where fasteners are subjected to high temperatures of the order of 800 to 900 F for long periods of time. In comparison with standard socket-head screws that are widely used for general purposes, the standard covers fasteners with larger head proportions to provide greater area on the bearing surface of the head and to assure greater strength in the head and wrenches than in the body or threaded portion of the bolt in view of materials and other factors involved. Price is 35 cents.

Pipe Sizes

American Standard Wrought-Steel and Wrought-Iron Pipe, ASA B36.10–1950: This is a revision of the 1939 standard. Because of the persistent use of traditional designations of standard weight, extra-strong, and double-extra-strong pipe, the revised standard contains two new tables which list the traditional pipe-wall thicknesses. The tables for wrought-iron welded pipe were completely revised to conform to usage which has followed pipe made to commercial dimensions instead of those equivalent to schedule-wall pipe shown in the 1939 edition. The 12-page standard includes seven tables. Price is 65 cents.

Heat-Power Symbols

Forty-four graphical symbols considered by experts in the field of heat power to be a minimum requirement have been assembled in a new Standard on Graphical Symbols for Heat Power published by The American Society of Mechanical Engineers. The Standard is the sixth in the group which represents a revision and expansion of the 1941 Standard Graphical Symbols for Use on Drawings in Mechanical Engineering Z32.2. In selecting the symbols, clarity and simplicity were given paramount consideration. Only those symbols about which there was a nationwide consensus were included. Copies may be obtained from the Order Department, ASME, 29 West 39th Street, New York 18, N. Y. Price is 35 cents.

Fatigue Testing

USEFUL information on setting up new fatigue-testing laboratory facilities covering proper operation of equipment and advice on presentation and interpretation of data has been compiled by Committee E-9 on Fatigue of the American Society for Testing Materials in a "Manual on Fatigue Testing" which was recently published. The 82-page manual is profusely illustrated and contains eight sections covering nomenclature of fatigue testing, fatigue-testing machines, specimens and their preparation, test procedure, and preparation of data. R. E. Peterson, Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa., is chairman of Committee E-9. Copies of the manual may be obtained from ASTM, 1916 Race Street, Philadelphia, Pa. Price is $2.50.

Nuclear Glossary

SECTION V, Chemical Engineering, of a proposed American Standard Glossary of Terms in Nuclear Science and Technology was issued recently in a preliminary edition by The American Society of Mechanical Engineers.

It is the second of a series of nine pamphlets which will cover nuclear terms in major fields of science and technology. The glossary is sponsored by a conference of 21 scientific societies and agencies organized by the National Research Council in June, 1948.

Section V consists of eight pages of definitions and 20 pages of an alphabetical index of terms appearing in all nine of the sections.

The following sections of the glossary will be issued in the near future: I, General Terms; II, Reactor Theory; III, Reactor Engineering; IV, Chemistry; VII, Instrumentation; VIII, Isotopes Separation; and IX, Metallurgy. Section VI covering nuclear terms used in Biophysics and Radiobiology was published last month. Copies of Sections V and VI may be obtained from the Order Department, ASME, 29 West 39th Street, New York, N. Y. Price per Section is 60 cents.

Machinery Foundations

PUBLICATION of the fifth of a series of bibliographies compiled by the Engineering Societies Library, New York, N. Y., was announced recently. Known as "ESL Bibliography No. 5," the new compilation contains 120 annotated references to selected books and periodical articles published between 1924 and 1949 on theory, design, and construction of machinery foundations. The bibliography may be obtained from the Engineering Societies Library, 29 West 39th Street, New York 18, N. Y. Price is $2.

Aeronautical Symbols

A REVISION of the 1930 American Standard on Letter Symbols for Aeronautical Sciences was recently published by the American Standards Association. The 19-page standard lists the symbols alphabetically by symbol and by concept for use of authors writing in the aeronautical sciences. Copies may be obtained from Order Department, ASME, 29 West 39th Street, New York 18, N. Y. Price is $1.25.

Research

PROCEEDINGS of the 1949 annual meeting of the Engineering College Research Council of the American Society for Engineering Education has been published as a 140-page paper-bound book. A feature of the Proceedings is a 12-paper symposium on Instrumentation for Engineering Research. Copies may be obtained from Engineering College Research Council, State University, Iowa City, Iowa. Price is $2.

People

James D. Cunningham Receives 1950 CTSC Merit Award

TRENDS in education, political thinking, and religion currently affecting American engineers as members of a complex technical society were reviewed by James D. Cunningham, president ASME, in an address given on the occasion of his acceptance of the 1950 Merit Award of the Chicago Technical Societies Council, Chicago, Ill., May 9, 1950.

Speaking on "Technical Knowledge Is Not Enough," President Cunningham declared that technical progress in itself did not make for happiness, an essential ingredient of which was a balance of technical and spiritual forces. Quoting several engineering educators, Mr. Cunningham pointed out that engineers were beginning to realize that technical know-how was not the only objective of their efforts.

Students who are being exposed to "this changing emphasis in technical education," President Cunningham declared, are likely to be "less keen as technical specialists than their predecessors have been . . . . . but they might be more keen as citizens and as human beings."

Referring to the current trend toward socialism in America, President Cunningham pointed out that the trend arises not alone from the will of politicians but from the will of the people seeking "justice, tranquillity, and the general welfare." He deplored the fact that so few technical leaders have in the past accepted even a minimum of political responsibility. There are a few signs, he said, that more engineers were turning away occasionally from their professional and business lives to accept responsibilities in the educational and welfare activities of the community. If democracy is to work, professional men must be willing to accept the high responsibility of office-holding.

President Cunningham expressed encouragement over the awakening interest in spiritual and moral as well as technical values reflected in the growing church membership and the popularity of inspirational books on American campuses. He asked engineers to turn aside for a moment from technical progress to contemplate the greatest admonition that has ever been given to men: "Love thy neighbor as thyself." This is the way out of the many difficulties which confront the country, he declared.

The CTSC Merit Award is conferred annually "on men who have gone far beyond technical skills and have achieved national recognition in civic, educational, and administrative services."

In presenting the award, Gustav Egloff, director of research, Universal Oil Products Company, said of President Cunningham that he was a man who measured up to all of these specifications. R. H. Bacon, Mem. ASME, president CTSC, presided at the presentation ceremony.

GUSTAV EGLOFF (*left*) AND JAMES D. CUNNINGHAM AT CTSC CEREMONY

WILLIAM G. CHRISTY, Mem. ASME, was recently appointed director of the Bureau of Smoke Control, New York, N. Y., by Mayor William O'Dwyer. Mr. Christy was recommended for the position by a committee of seven engineers appointed by the Metropolitan Sections of The American Society of Mechanical Engineers, American Society of Heating and Ventilating Engineers, and the National Association of Power Engineers. Walter L. Fleisher, Mem. ASME, a New York City consulting engineer, was chairman. Mr. Christy is well known for his work in smoke abatement in St. Louis, Mo., and Jersey City, N. J. In his new post Mr. Christy will have charge of smoke and dust abatement in the five boroughs of New York, N. Y. He will be assisted by Rear Admiral William S. Maxwell, recently retired, who was appointed deputy director. Mr Christy has served on many national committees of the ASME and in 1941–1944 was a manager of the Society.

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BONNELL H. ALLEN has been appointed by the Engineering Societies Personnel Service, Inc., to serve as assistant to Joseph R. Decker, manager, Chicago office of the service.

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FRANK B. JEWETT received, posthumously, the 1950 medal of the Industrial Research Institute for outstanding accomplishment in the management of industrial research. The medal was accepted by his son, Frank B. Jewett, Jr., Jun. ASME.

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HANS ERNST, Fellow ASME, director of research, The Cincinnati Milling Machine Company, Cincinnati, Ohio, was recently named "Cincinnati's Outstanding Engineer for 1949–1950" by the Technical and Scientific Societies Council of Cincinnati.

ASME Elects Two Fellows

THE American Society of Mechanical Engineers has honored two of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men who, by virtue of their contributions to their profession and to the Society, were so honored are:

Phil Carroll

PHIL CARROLL, consulting industrial engineer, was promoted to the grade of Fellow ASME.

In 1918 he received a BSEE degree and in 1940 an ME degree, both from the University of Michigan. From 1919 to 1923 Mr. Carroll was employed by the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa., and two of its other plants. In 1924 he was one of the founders of Dyer Engineers, Inc., Cleveland, Ohio, and served as chief engineer in charge of several simultaneous installations of time study, wage incentive, and cost control. Later he became vice-president and director of the firm. Since 1939 he has conducted his own consulting practice in these fields and trained clients' personnel. He is the author of two books, has contributed to three other books, and more than 50 of his articles and book reviews have been published in technical magazines. As a member of ASME he was co-chairman, Time Study and Methods Conference, 1950; and serves on the National Management Council, Management Division Committee, and Gantt Medal Committee. He is active in several other technical organizations among which are: SAM, AIEE, and is president, Technical Societies Council of N. J., 1950.

Burgess Hill Jennings

BURGESS H. JENNINGS, chairman of the department of mechanical engineering at Northwestern University, and engineering consultant to the Argonne National Laboratory, was born in Baltimore, Md., Sept. 12, 1903. Mr. Jennings has been an outstanding educator in the field of mechanical engineering and he has contributed greatly to the development of many young men who themselves have become outstanding teachers in the field. Many of his other students have been exceptionally successful and hold excellent jobs in the engineering world at the present time. He is the author of many papers and books. Three textbooks which he co-authored have been used extensively in engineering schools. He holds patents on absorption-refrigeration devices and a glycol vaporizer.

ASME NEWS

Semi-Annual Meeting and Two Conferences Make June a Busy Month for ASME

JUNE is usually a month of heightened activity in The American Society of Mechanical Engineers. With the Semi-Annual Meeting in St. Louis, Mo., and national conferences in Baltimore, Md., and Lafayette, Ind., all scheduled for June, this year is no exception.

Members who feel a stirring within them caused by bright June weather should quickly turn back to the May issue and read again the diversified programs for the ASME June meetings. Every member, no matter what his divisional interest, should have his curiosity piqued by the titles of papers or by the authorities who will present them. While the technical programs are the main attractions, there are many others to help make attendance at the meetings a pleasure for the whole family. In June, who can pass over an invitation to luncheon in Baltimore, a moonlight sail on the Chesapeake, a river excursion on the Mississippi, a night under the stars at the Municipal Opera, a sightseeing tour of St. Louis, or conducted tours through some of the finest industrial plants in the country? Yet all these events are the whipped cream and icing about technical programs which are in themselves delicacies for engineers.

Semi-Annual Meeting

The ASME St. Louis Section is standing by to play host to members in the air-conditioned Hotel Statler, where the 1950 Semi-Annual Meeting will be held, June 19–23. For a glimpse of the hustle and bustle of the Society in action, no meeting except perhaps the Annual Meeting, gives such a good idea of the amount of individual planning and effort that goes into the operation of the Society. At St. Louis, the Regional Delegates Conference will meet to discuss suggestions for improving Society services to members. The Regular Nominating Committee will hear members who wish to present views concerning candidates for Society offices and will then name the slate for 1951. The official business meeting of the Society will give members an opportunity to vote personally on Society policy. Among the 30 technical sessions described in the tentative program which appeared on pages 438–440 of the May issue, each member should find papers he can listen to with interest. Members, especially those residing in the Midwest, should not miss the attractions of the 1950 Semi-Annual Meeting in St. Louis.

Oil and Gas Power Conference

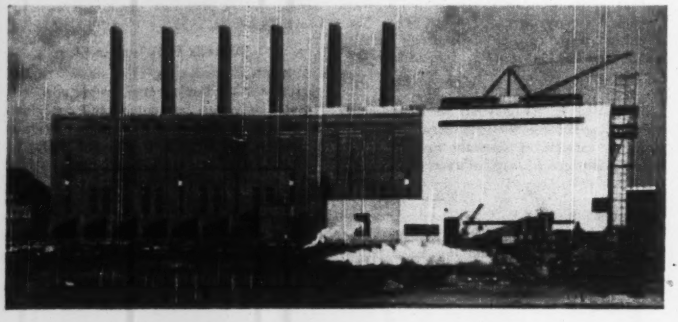
For members interested in the oil and gas-power industry, the ASME Oil and Gas Power Division has arranged five profitable and pleasant days at the Lord Baltimore Hotel, Baltimore, Md., June 12–16, 1950, for the 1950 ASME Oil and Gas Power Conference. For a full description of the technical program see page 441 of the May issue. Among the high lights of the program will be the first public report on the design features of a unique radial Diesel built by the Nordberg Manufacturing Company and test data on the new Berry hydraulic transmission. A feature of the conference will be a lecture series on corrosion, delivered by experts on the subject. Inspection trips and a boat trip to the U. S. Naval Experiment Station wind up a program which should not be missed.

Applied Mechanics Conference

The ASME Applied Mechanics Division will hold its 1950 conference at Purdue University, Lafayette Ind., June 22–24, 1950. For the technical program, see pages 441–442 of the May issue.

On June 22 a lawn party will be held in Cary Hall Court. At a banquet on Friday, June 23, A. A. Potter, past-president and honorary member ASME, will speak on the engineering teacher.

Arrangements have been made for campus accommodations for single men and married couples. For reservations, members should write to M. M. McClure, Technical Extension, Purdue University, Lafayette, Ind.



VENICE POWER PLANT OF THE UNION ELECTRIC COMPANY, ONE OF THE MANY INSPECTION-TRIP ATTRACTIONS OF THE ASME 1950 SEMI-ANNUAL MEETING, ST. LOUIS, MO., JUNE 19–23

Tax-Free Status Limits ASME Legislative Role

AS A nonprofit professional society chartered to promote the "arts and sciences connected with engineering and mechanical construction for scientific purposes," there is a limit to official actions which The American Society of Mechanical Engineers can take respecting state and federal legislation if it is not to endanger its tax-free status.

This is the gist of the Manual on Society Legislative Activities prepared by the Secretary to serve as a guide to members interested in having the ASME express opinions of the merits of pending legislation.

The ASME charter of incorporation which specifies the kind of activities in which the Society can legally engage, empowers the Council or Sections to express opinions on the merits of legislation having a direct bearing on "arts and sciences connected with engineering and mechanical construction," but not on legislation having to do with the welfare of engineers and their social and economic conditions.

When the Society goes beyond the mere expression of opinion and circularizes public and legislative bodies, it could be considered to be carrying on propaganda to influence legislation in a way forbidden to tax-exempt organizations.

The manual points out that the Society does not have to register under the Federal Regulations of Lobbying Act because it does not employ any person to influence either state or federal legislation. When an ASME member appears before a congressional committee to present Society views, he does so at his own expense.

Copies of the manual may be obtained on request from the secretary.

Need a Good Speaker for a Fall Meeting?

YOUNG engineers looking for opportunity should not overlook the field of machine design, according to Thomas F. Githens, chairman, Student Talks Committee of the

C. E. DAVIES, SECRETARY ASME, WITH T. KEITH LEGARE, EXECUTIVE SECRETARY, NCSBEE, IN COLUMBIA, S. C., DURING HIS RECENT SIX WEEKS' NATIONWIDE TOUR OF ASME SECTIONS AND STUDENT BRANCHES

Machine Design Division of The American Society of Mechanical Engineers.

To make these opportunities known to young men, the Division has compiled a list of 28 speakers residing mostly in the East and Midwest, who have agreed to talk before ASME Sections and student branches on the topic, "Opportunities in Machine Design."

Mr. Githens said that many engineering graduates are overlooking good careers in machine design, especially those with a creative bent who are naturally adapted to this type of work, because they seem to think there is a brighter future for them in other branches of mechanical engineering such as sales, production, and management.

The list of speakers should be an aid to program chairmen of Sections and junior groups who might want to schedule sometime in the fall an orientation type of program for recent graduates.

The men on the list are all good speakers and have had many years of experience in machine-design work.

Program chairmen should correspond directly with the speakers and send a copy of the invitation to T. F. Githens, Cleveland Twist Drill Company, 1242 East 49th St., Cleveland 14, Ohio. The list of speakers follows:

J. M. Anderson, Otis Elevator Company, 256 11th Avenue, Otis Building, New York, N. Y.

G. E. Burke, Caterpillar Tractor Company, Peoria 8, Ill.

H. C. R. Carlson, The Carlson Company, 277 Broadway, New York 7, N. Y.

Colin Carmichael, *Machine Design*, Penton Building, Cleveland 13, Ohio

E. W. Clem, Rice Barton Corporation, Worcester, Mass.

Myron S. Curtis, The Warner and Swasey Company, 5701 Carnegie Ave., Cleveland 3, Ohio

Philip T. Elliot, Eastman Kodak Company, Rochester, N. Y.

T. E. Eserkaln, Wauwatosa 13, Wis.

A. C. Fulton, Westinghouse Electric Corporation, Philadelphia, Pa.

B. P. Graves, Director of Design, Brown & Sharpe Manufacturing Company, P. O. Box 1385, Providence 1, R. I.

Emil Grieshaber, Nordberg Manufacturing Company, Chase and Oklahoma Ave., Milwaukee, Wis.

G. F. Habach, Worthington Pump Corporation, Harrison, N. J.

Howard Heywood, Kearney and Trecker Corporation, 6784 West National Ave., Milwaukee 14, Wis.

R. E. Kline, The National Cash Register Company, Dayton 9, Ohio.

A. R. MacAlmon, Business Machines Corporation, Endicott, N. Y.

Arthur Mortimer, Ford Motor Company, Dearborn, Mich.

Forest Nagler, Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

L. F. Nenninger, The Cincinnati Milling Machine Company, Cincinnati 9, Ohio

L. E. Newman, Turbine Div., General Electric Company, River Works, West Lynn 3, Mass.

G. F. Nordenholt, *Product Engineering*, 330 W. 42nd St., New York 18, N. Y.

F. J. Oliver, *Electrical Manufacturing*, Gage Publishing Company, 1250 Ave. of Americas, New York 20, N. Y.

R. R. Raney, International Harvester Company, 180 N. Michigan Ave., Chicago, Ill.

C. Schabtach, General Electric Company, Schenectady, N. Y.

H. B. Sizer, Brown and Sharpe Manufacturing Company, P. O. Box 1385, Providence 1, R. I.

J. F. Downie Smith, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa

D. V. Waters, Western Electric Company, Kearny, N. J.

F. R. Wodtke, General Motors Corporation, Hyatt Bearings Division, Harrison, N. J.

C. H. Young, The Cooper Union, Department of Machine Design, Cooper Square, New York 3, N. Y.

Nation's Capital Host to 1950 ASME Spring Meeting

Record Number Attend

MORE than 1000 ASME members and guests attended this year's ASME Spring Meeting, held at the Hotel Statler, Washington, D. C., April 12–14, 1950, breaking the record for attendance at any previous Spring or Fall Meeting. Not since the ASME held its Fiftieth Anniversary Meeting in the spring of 1930 in the Nation's Capital has the Society convened there. A comprehensive technical program, luncheon meetings, and a banquet, inspection trips to numerous government laboratories, and an attractive women's program were offered.

Diversified Technical Program

A diversified program, which consisted of 19 technical sessions and some 40 papers, provided stimulating fare for those who wanted to keep abreast of engineering progress and developments. For example, the gas-turbine sessions covered free-piston gasifiers, the 3500-hp experimental gas-turbine plant at Annapolis, British marine gas-turbine research, and the prospects of gas turbines in naval applications.

Safer flying and safety in aviation were highlighted on the program. One paper presented a statistical picture of aircraft accidents. Other papers discussed more air traffic with greater safety and the development of cross-wind undercarriages for airplanes.

In the steam-power field, the latest technique for the quick starting of large steam turbines and boilers, and a method of sealing high-pressure steam safety valves, were given.

Electric induction drives, cable-pulley friction, cam-follower systems, and the design of a precision lens-testing and copying camera, were featured on the machine-design program.

Papers in the wood-industries field covered a survey of postwar developments in wood-products research; how increased mechanical efficiency is being obtained in the southern-pine region; machines and forestry; and wood-cutting tools and equipment.

Other topics included fly-ash collection and equipment for small plants; the development of an arc-heating method in metal cutting which results in a surprising improvement in machinability at elevated temperatures; factors to be considered in locating process-industries plants; and a restricted symposium on turbojet gas-turbine anti-icing.

Technical sessions were also held on fuels, rocketry, management, heat transfer, indus-

PRINCIPAL SPEAKERS AT 1950 ASME SPRING-MEETING BANQUET

(*Left to right:* William L. Batt, toastmaster; Detlev W. Bronk, principal speaker; and James D. Cunningham, president ASME.)

trial instruments and regulators, education, applied mechanics, metals engineering, and lubrication.

An additional feature was the presentation of the Robert Henry Thurston Lecture by Dr. Theodore von Kármán, on the subject of "Specific Power Required for Propulsion of Vehicles (What Price Speed?)." Co-author was Guiseppe Gabrielli, chief engineer of the Fiat Aircraft Works, Turin, Italy.

Digests of 30 of the papers presented at this meeting appear in the "ASME Technical Digest" on pages 496–505 of this issue. Five other papers are scheduled for publication in forthcoming issues of MECHANICAL ENGINEERING. Pamphlet copies of these papers are available from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. When ordering, please give title, author, and paper number. Price is 25 cents per copy to ASME members.

Senator Flanders Speaks

The first public event of the 1950 ASME Spring Meeting at Washington was a welcoming luncheon held on Wednesday noon at the Hotel Statler. W. G. Allen, chairman of the ASME Washington Section, welcomed members and guests and introduced some local committeemen and national officers who sat with him at the head table—in particular, Rudolph Michel, chairman of the local meeting committee, who spoke briefly.

The principal speaker at the luncheon was Ralph E. Flanders, U. S. Senator from Vermont, an honorary member and past-president of the Society, who was introduced by James D. Cunningham, president ASME.

Mr. Flanders expressed his gratification in discovering that since his duties had robbed him of the privilege of meeting with the Society as frequently as had been his custom in the past, the Society had come to Washington to meet with him. He was, as the announced title of his address indicated, a mechanic in the Senate. Regardless of any doubts he might have of being an engineer or a statesman, he knew, he said, that he was a good mechanic, and it was as a mechanic that he was serving in the Senate. A mechanic, he pointed out, had to be sure that what he was working on would work.

Most of his colleagues in the Senate, Mr. Flanders reported, called themselves either liberals or conservatives, although some did not know what they were nor did they care. In his opinion, a liberal had to be particularly concerned with the workability of the legislation he proposed, because a liberal's approach was from the standpoint of people. A conservative's approach, he pointed out, was from the standpoint of institutions, such as, for example, the system of free enterprise. Liberals and conservatives both played useful parts. It was clear to him that a liberal, with his forte of making innovations, of helping people, of making their lives better and easier, and of assisting them to exercise their right to "life, liberty, and the pursuit of happiness," needed an infusion of a mechanic's point of view. For it is much easier, he said, to think of what it is nice to do than it is to devise means of doing it. Where the liberals failed, he declared, was in not making sure that what they were trying to do would work.

SENATOR RALPH E. FLANDERS, SPEAKER, AND JAMES D. CUNNINGHAM, PRESIDENT ASME, AT THE WELCOMING LUNCHEON

To illustrate his point, Mr. Flanders gave as an example the redistribution of wealth. This, he said, was an obvious and natural thing to do and had been going on in legislation for a long time. Some of its limitations were becoming obvious, but some of its dangers were not as yet completely apparent. He then pointed to the manner in which redistribution of wealth was working out in Great Britain. There, he said, success in reducing the incomes of the wealthy was approaching the point where there was not much left to redistribute. Greatly expanded social services were being made available as a result of this redistribution, the most costly of which were food and health subsidies, but, he pointed out, the British citizen was finding out that he himself was paying for these services. In Mr. Flander's opinion, a mechanic should be able to think up a better end product than had been devised in Great Britain.

The Brannan plan was another of Mr. Flander's illustrations. It held, in his opinion, one good idea—a free market for the consumer. But in guaranteeing an income for the farmer, this nation was moving in the direction taken by Great Britain in proposing large-scale redistribution which has to be paid for ultimately by the person to whom the income is being redistributed. If the income of the farmer were to be guaranteed, Mr. Flanders asked, why not guarantee everybody's income—engineers, stockbrokers, and all others. There was no limit to such guarantee in logic.

It was possible, Mr. Flanders thought, to write out specifications for a sound agricultural policy, and he suggested four points which such specifications should cover: (1) Free prices and a free market; (2) The farmer should remain a free American citizen and be permitted to sow and reap as he desired; (3) He should be protected from disaster just as the wage earner is protected by unemployment insurance; (4) The cost in prices and taxes should be less than it now is.

Mr. Flanders left delineation of his policy "to a future date" and ended by saying that "neither Republicans nor Democrats wish to have the subject stirred up until after the elections."

Marshall Plan Discussed

William C. Foster, Mem. ASME, deputy administrator of the Economic Cooperation Administration, called upon the United States to lower its tariffs and face competition from increased imports "willingly" in order to assure the success of the Marshall Plan and the economic recovery of Western Europe. Such a procedure, he said, would enable deficit countries to earn enough of our dollars to pay for the goods they need and can get only from us. He addressed ASME members and guests at Thursday's luncheon meeting.

The people of Europe today are eagerly trying to learn what we want to buy from them, he said, and from here on in we must be more willing to let them sell to us. It makes little sense, he declared, for a great creditor nation to maintain artificial barriers to trade, thereby preventing deficit countries from closing their dollar gap. In 1947 that gap was $8.9 billion, in 1948, $7 billion, and in 1949 it was just under $4.5 billion. The difference has largely been made up by grants or loans from us.

What happens in Western Europe in the next few years well may determine what happens in the United States in the coming decades, he declared. Neither the freedom of the Europeans, nor our own freedom, will be secure until Europe is solvent. If Europe truly recovers, we can with safety make a drastic cut in our own military expenditures. In fact, the security produced by the Marshall Plan in the last two years perhaps has enabled us already to reduce military expenditures and thus save more than the cost of the Marshall Plan to date.

As leaders we are asking the Europeans to take bold new steps in breaking down nationalist barriers and in assuming new risks of competition, he said. In turn, it is fair to expect us—the free world's major creditor and supplier—to be willing to face competition from increased imports and to accelerate the trend toward lower tariffs and easier customs procedures, he said.

F. M. Feiker, an associate member of ASME, and dean, George Washington University, Washington, D. C., acted as toastmaster.

Social Aspects of Science

At the banquet held on Thursday evening in the Presidential Ballroom of the Hotel Statler, W. L. Batt, past-president and honorary member, ASME, acted as toastmaster. Seated with him at the speakers' table were Frederick S. Blackall, jr., director at large, D. Robert Yarnall, past-president and honorary member,

THEODORE VON KÁRMÁN AND HUGH L. DRYDEN JUST BEFORE DR. VON KÁRMÁN DELIVERED THE THURSTON LECTURE ON "WHAT PRICE SPEED?"

SOME MEMBERS OF THE ASME WASHINGTON SECTION'S SPRING-MEETING COMMITTEE AT THE BANQUET

(*Left to right:* Mr. and Mrs. Rudolph Michel, Mr. and Mrs. W. G. Allen, Mr. and Mrs. R. L. Goetzenberger with Mrs. C. H. Berry in background, Mr. and Mrs. Charles C. Vogt, and Mr. and Mrs. F. M. Thuney.)

E. G. Bailey, past-president, James D. Cunningham, president, Ralph E. Flanders, past-president and honorary member, Alex D. Bailey, past-president and honorary member, Robert M. Gates, past-president, and the speaker, Dr. Detlev W. Bronk, president of The Johns Hopkins University and chairman of the National Research Council.

Mr. Batt recalled that the Fiftieth Anniversary of the Society had been celebrated in Washington in 1930, when he had been chairman of the Anniversary Committee, and cited some amusing incidents arising out of that occasion. He also introduced members of the American Rocket Society, which was co-operating with ASME in the 1950 Spring Meeting, and F. D. Herbert, chairman of the ASME Old Guard, who had with him representatives of six ASME student branches.

Mr. Cunningham conferred on Dr. Theodore von Kármán the certificate of the 1950 Thurston Lecture which had been delivered on Wednesday evening, and paid tribute to the Washington Section and to Mrs. Ralph L. Goetzenberger, chairman of the Women's Committee.

Dr. Bronk, in opening his inspiring and challenging address on some of the social aspects of science, conveyed to the Society the greetings of the National Research Council. It was the role of engineers, he said, to translate into human usefulness the discoveries of science. He spoke of intellectual freedom that had long been characteristic of science and declared that no superior authority had commanded the discoveries made by such men as Newton, Faraday, Pasteur, and Bohr. It was not possible, he declared, to direct the explorer into the unknown fields of his exploration. The course of science, he said, had always been profoundly influenced by its social aspects, and it had never been possible to predict the human values that might result from scientific discovery. Scientists were members of a complex social system and were tolerated and supported by that system only to the extent that their activities were understood and valued. It was the role of engineers to explain the implications of science. The changed material conditions of life made by engineers were based on the discoveries of science and resulted in new materials and sources of power and new moral issues and new human rights and human needs. Science provided the building stones of a better world, he asserted, but that world would be what we made it.

Speaking of the influence of science on the democratic social system, Dr. Bronk said that science need not be the obscure possession of a few because there existed the capacity of the multitude to understand it. Science had affected the relationships between the people of many lands. The radio, which could be an influence in public education, had also been used to poison the minds of entire nations. He recalled that Francis Bacon, in an address before the Royal Society, had suggested the formation of a group of men whom he called Merchants of Light who might penetrate all lands and bring back the advances of science and human knowledge for the benefit of their own countrymen. He quoted a famous directive of Benjamin Franklin to naval officers during the Revolution in which he charged them not to molest the expedition of Captain Cook but to allow it to return to England because the increase of geographical knowledge was a benefit to all and would increase the development of trade and the interchange of commerce and manufacture.

International affairs had changed vastly since Franklin's day, Dr. Bronk declared but he had faith to believe that the day would come when science and scientific knowledge would be looked upon as the rightful possession of people everywhere. He had been shocked at evidences he had witnessed of fear, and called upon the nation to have the same faith in its destiny that had sustained the founders of our government, for it was the primary function of a democracy to increase the rights and responsibilities of its citizens. He recalled the incident of the "dark day" when the members of the Connecticut Council threatened adjournment because an eclipse of the sun had led some of their members to believe that the Day of Judgment had come. One of their number, Abraham Davenport, had said that he did not know whether or not the Day of Judgment was at hand. If it was not, he said, there was no cause for adjournment, and if it were, he wished to be found doing his duty; therefore "Let candles be brought."

In conclusion, Dr. Bronk said that these were days which call for greatness and that the uses of science and technology for the benefit of human welfare was our common goal.

Interesting Inspection Trips

The U. S. Naval Ordnance Laboratory at White Oak, Md., which is devoted primarily to experimental work, was visited by 75 ASME members and guests on Wednesday morning, April 12, 1950.

On Wednesday afternoon 50 visited the Potomac River Generating Station, newest addition to the Potomac Electric Power Company's facilities, consisting of an 800,000-lb-per-hr steam boiler and an 80,000-kw turbine generator.

Approximately 100 ASME members and guests toured David Taylor Model Basin, Carderock, Md., on Thursday morning. Research and experiments involving changes in hull design to meet the needs for the constant demands for increased speeds are being carried out at this installation.

On Thursday afternoon a group of 75 ASME members and guests took the opportunity to see the National Bureau of Standards in Washington, D. C. A high light of the visit was a demonstration of the operation of the magnetic clutch, which was developed at the Bureau recently.

The facilities of the Timber Engineering Company Laboratory, located in northeast Washington, were also visited on Thursday afternoon. This laboratory works exclusively on wood-products research, and its studies range from microscopic examination of tiny pieces of wood to full-scale truss tests.

On Friday afternoon a group took a historical-interest trip to the U. S. Naval Academy, at Annapolis, Md. They visited the chapel and tomb of John Paul Jones, saw the many historical relics and memorials, toured the camp ground of the Continental Army, and saw the Spanish War prize ship *Reina Mercedes*. An inspection of the academy buildings concluded the visit.

Also on Friday afternoon another group visited the U. S. Naval Engineering Experiment Station. The inspection tour included internal-combustion-engine tests, reduction-gear measuring instruments, bearing-test machines, metals laboratory, gas-turbine laboratory, lubricant tester, and the shock and vibration equipment.

Women's Program

The Women's Committee for the ASME Spring Meeting, headed by Mrs. R. L. Goetzenberger and Mrs. W. G. Allen, arranged an attractive program for the three-day affair.

On Wednesday there was a welcoming luncheon at the Hotel Statler, after which the women were free to sightsee, shop, play bridge, and view the cherry blossoms.

The outstanding event on Thursday was a tea at Blair House for 100, at which Mrs. Truman was the hostess. A cocktail hour at the Hotel Statler followed and in the evening the women attended the banquet for members and their wives.

Friday was devoted to a guided bus tour to Mt. Vernon, followed by luncheon at Collingwood Inn, and return via Lee's Mansion and Arlington. For those who did not take this trip, there was a visit to Annapolis.

Committees

The following committees of the Washington Section were responsible for the success of the meeting: *General*, Rudolph Michel, chairman, Harry P. Harwood, vice-chairman; *Finance*, W. G. Allen, chairman, Mrs. R. L. Goetzenberger, C. C. Vogt, B. C. Cruickshanks, C. E. Greeley, H. P. Harwood, J. B. Clark, G. A. Vacca, F. M. Thuney, R. Michel; *Technical Events*, Charles A. Shreeve, Jr., chairman, J. W. Jackson, R. Michel; *Printing and Signs*, Charles C. Vogt, chairman, L. J. Lofthus, J. B. Clark; *Entertainment*, Charles E. Greeley, chairman; *Reception*, Ralph L. Goetzenberger, chairman, L. W. Cadwallader, E. P. Carman, W. F. Dietz, F. J. Hanrahan, W. K. Karsunky, M. E. Weschler, H. L. Whittemore, M. X. Wilberding; *Publicity*, Charles E. Berberich, chairman, P. H. Benziger, J. L. Price, Jr.; *Information and Registration*, H. H. Snelling, chairman; *Trip*, Benjamin C. Cruickshanks, chairman; *Hotel*, Francis M. Thuney, chairman; *Women's Committee*, Mrs. Ralph L. Goetzenberger, chairman.

600 Attend Process Industries and Pittsburgh Section Conference

PROBLEMS of dust collection and control and the application of oxygen plants to the process industries were the most popular subjects at the Process Industries Division and the Pittsburgh Mechanical Engineering Conference held at the William Penn Hotel, Pittsburgh, Pa., April 24–27, 1950. More than 600 engineers, industrial executives, engineering students from the University of Pittsburgh, Virginia University, and the Carnegie Institute of Technology took part in the program of technical sessions, luncheons, and dinner, and the two inspection trips to local industrial plants.

Co-operating in the conference were the Mechanical Section of the Engineering Society of Western Pennsylvania and the Pittsburgh Chapters of the Society for the Advancement of Management and the American Materials Handling Society. The symposium on dust collection and control problems, which aroused much discussion, consisted of seven talks by experts on bag-type dust-collector problems; application, operation, and maintenance of filter-type dust collectors, value of dust control from the engineering and management point of view, and many others. The social part of the program commenced with a welcome luncheon at which A. C. Pasini, vice-president, ASME Region V, T. R. Olive, chairman, ASME Professional Divisions Committee, A. M. G. Moody, chairman, ASME Pittsburgh Section, and Philip Freneau, chairman, ASME Process Industries Division, spoke.

Some 300 members and guests, including more than 100 students, attended the banquet at which James D. Cunningham, president ASME, spoke on "The Engineer's Civic Responsibility."

Four distinguished members of the Pittsburgh Section were honored with the presentation of Fellow grade certificates. They are: R. E. Hall, director, Hall Laboratories Inc.; Sidney Dillon, retired; M. A. King, vice-president in charge of engineering, Elliott Company, Jeannette, Pa.; and Isaac Harter, chairman of the board, Babcock and Wilcox Company. On Wednesday afternoon, April 26, more than 60 members made a trip to the Babcock and Wilcox Tube Company plant in Beaver Falls, Pa., to see the production of seamless steel tubing and the recently developed continuous-steel-casting process. The final event of the conference was an inspection trip to the Robena Mine of the H. C. Frick Coal Company, near Uniontown, Pa. On this trip 80 members were conducted to the underground dumping station and then followed the path of the coal through the screening and breaker building, blending bin, and washing plant to the river loading tipple.

NEW FELLOWS OF THE ASME PITTSBURGH SECTION WHO RECEIVED CERTIFICATES AT THE 1950 PROCESS INDUSTRIES DIVISION AND PITTSBURGH MECHANICAL ENGINEERING CONFERENCE

(*Left to right*: Sidney Dillon, M. A. King, R. E. Hall. Isaac Harter, who is not shown, also received a Fellow grade certificate. A. M. G. Moody, who made the presentation, is shown at the extreme right.)

EARLE BUCKINGHAM IS GUEST OF ASME CHICAGO SECTION

(*Left to right:* W. P. Schmitter, Professor Buckingham, and Alexander Cowie.)

Earle Buckingham Addresses Chicago Gear Meeting

AN audience of over 400 representatives of the gear industry from Chicago, Milwaukee, Rockford, Aurora, Peoria, and Indianapolis met on April 4, 1950, at the Furniture Club of America, Chicago, Ill., to hear Earle Buckingham, professor of mechanical engineering, Massachusetts Institute of Technology, and noted gear analyst, speak on the subject, "Gear Selection."

Professor Buckingham, Mem. ASME, Worcester Reed Warner Medalist for 1944, discussed the advantages and limitations of the various types of gears. From a wide background of experience he cited cases where spiral or screw gears, which are ordinarily considered of little power-carrying capacity, had, by proper selection of materials and a sufficient wear-in period, been found capable of transmitting surprising amounts of power.

In the field of bevel gears the speaker stressed the advantage of short face widths, and on worm gears the benefits to be obtained by lowering the pitch line on the gear. He also stated that so far tests have not indicated that an upper limit for pitch-line velocities exists.

The meeting was arranged by the Chicago Section of The American Society of Mechanical Engineers and was cosponsored by ten of the leading gear companies in the Chicago area. The speaker was introduced by W. P. Schmitter, chief engineer, Falk Corporation, Milwaukee, Wis., and Alexander Cowie, Chicago Section chairman, presided. The talk was followed by a question-and-answer period.

ASME Standards Workshop

SUBSTANTIAL progress was reported on revision of the Code for Pressure Piping. Four revised sections on steam-power piping, oil piping, district-heating piping, and fabrication details have been completed and sent to the Sectional Committee for approval. Two other sections on gas and air piping and refrigeration piping are in the final stages of revision.

Approval by the Sectional Committee is a major step in developing a standard. When ASME is a sponsor, approvals by the ASME Standardization Committee and the Board on Codes and Standards are next obtained. The American Standards Association then receives the proposal for approval of procedure and designation as an American Standard. This is usually granted after determining that interested parties affected by the proposed standard had an opportunity to present their opinions.

The last issue of the Code was in 1942. Developments in the piping art were incorporated by supplements published in 1944 and 1947 to keep the Code up to date. These supplements were somewhat difficult to use because it was necessary to refer to the original code and to both supplements to determine many items. The proposed revision will be published as a completely new edition consisting of one continuous text.

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S. A. TUCKER, of the ASME staff, attended a meeting of the working committee of ISO (International Organization for Standardization) Technical Committee No. 1, held in Paris, April 17-20, 1950, as a representative of the ASME and the Society of Automotive Engineers, sponsors of the American Standards Association Sectional Committee B1 on Standardization and Unification of Screw Threads. The ISO group has under consideration world-wide standardization of screw threads.

As a result of the meeting Mr. Tucker reported that tasks were assigned for setting diameter, pitches, and profile for threads less than 3-mm diam. The task committee also completed work on a tentative series for small threads and proposed certain diameter and pitches for threads up to and including 8 mm.

The cordial atmosphere prevailing during the meeting encouraged the hope that the metric thread could be harmonized with the unified thread system recently approved by Canada, Britain, and the United States. The working committee planned its next meeting for September in Zurich, Switzerland.

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SECTIONAL Committee B32 on Standardization of Wire and Sheet Metal Gages held a reorganization meeting in New York, N. Y., April 25, 1950. I. V. Williams, Bell Telephone Laboratories, Inc., New York, N. Y., was elected chairman. One of the major items on the agenda was the question of developing an American standard wire gage to replace the many methods of designating wire sizes now in use. When such a proposal was first brought forth before the Committee became inactive, it was opposed by the electrical industries which felt that the proposed standard would upset present sizes for electric conductors and would cause general confusion in the industry. This opposition was overcome by an agreement to restrict the standard to wire for mechanical purposes.

As soon as drafts of the proposed standard are available, these will be circulated among interested persons for comment.

* * *

A NEW project to standardize arbor sizes for woodworking machinery using circular saws and cutters won the support of the ASME Wood Industries Division at a meeting of its executive committee held on April 14, 1950, in Washington, D. C. The action was based on a survey of 164 machinery manufacturers which confirmed the need of standardization of arbors in saw-diameter relationships of woodworking machinery. Some 280 sizes were reported by 64 manufacturers.

The project also won the support of the Associated Manufacturers of Woodworking Machinery who appointed the following committee to study the project: L. H. Geddes, Greenlee Bros., Rockford, Ill., chairman; M. A. Bell, Bell Machine Company, Oshkosh, Wis.; C. C. Porter, Porter Machinery Company, Grand Rapids, Mich.

The ASME survey was conducted by a temporary committee composed of the following: R. D. Brooks, E. C. Atkins & Company, Indianapolis, Ind.; N. C. Bye, Henry Disston & Sons, Philadelphia, Pa.; F. P. Forbes, Weyerhaeuser Timber Company, Newark, N. J.; E. D. May, Baxter D. Whitney & Sons, Winchendon, Mass.; C. L. Babcock, Babcock Machinery Company, New York, N. Y.; W. Burdette Wilkins, Ridgewood, N. J.; and Thomas D. Perry, consulting engineer, Moorestown, N. J.

Junior Forum

National Junior Committee Conference Takes Up Professional Development

YOUNG engineers seeking to evaluate their professional development must do more than consider the degree of proficiency obtained in their field of engineering. They must consider also their ability and willingness to assume responsibility in community and national projects. Growth in all three of these spheres of action is the direct measure of professional development.

This was the consensus of the Junior Conference sponsored by the National Junior Committee at the ASME 1950 Spring Meeting, Washington, D. C., April 12–14, 1950.

The conference was planned to point out to younger members the meaning of professional development. Although the conference theme was "How's Your P.D.?" (professional development), elder members who participated suggested that growth was a better idea for young engineers to contemplate than development.

H. Donald Moll, chairman, opened the meeting by introducing F. G. Herbert, chairman, Old Guard Committee, who in turn welcomed the delegates whose travel expenses to the conference were paid by the Old Guard Committee. These delegates were young men chosen from Sections in Region III. They were: *Anthracite-Lehigh*, William J. Helvig, Hazelton, Pa.; *Baltimore*, Arthur G. Foster, The Johns Hopkins University, Baltimore, Md; *Buffalo*, Raymond G. Tessmer, Sr., Niagara Filter Corporation, Buffalo, N. Y.; *Central-Pennsylvania*, Edwin P. Nye, The Pennsylvania State College, State College, Pa.; *Philadelphia*, H. Donald Moll, Elliott Company, Philadelphia, Pa.; *Plainfield*, Charles Weiscoff, Elizabeth, N. J.; *Rochester*, William P. Wier, Jr., Bausch and Lomb Optical Company, Rochester, N. Y.; *Schenectady*, Lindon E. Saline, General Electric Company, Schenectady, N. Y.; *Southern Tier*, W. R. Stewart, International Business Machines Corporation, Endicott, N. Y.; *Susquehanna*, Robert E. Coates, S. Morgan Smith Company, York, Pa.; *Syracuse*, William C. Franklin, Syracuse, N. Y.; *Washington*, F. H. Kohloss, Green Acres, Washington, D.C.

Mr. Herbert reviewed some of the activities of the Old Guard, the membership of which is made up of men who, after having paid dues for thirty-five years, are exempt from further payment of dues. These men, he said, had found that writing an annual check for dues had become such a pleasant habit that they continued the practice when they became members of the Old Guard. The money thus accumulated, he revealed, was under the jurisdiction of the Old Guard Committee which was free to spend it for the betterment of engineering and the Society. One of the projects of the Old Guard was to invite as a guest at the Spring Meeting a young man from each Section located in the Region in which the meeting was held. It was the Committee's thought that such a project would give these young men an opportunity to take an active part in a program sponsored for their benefit.

Advice From the President

President Cunningham, who was present, said that he was pleased that such a program was being carried out and that the younger members were taking an interest and an active part in the Society. "Wearing the pin and

SOME OF THE JUNIOR MEMBERS WHO ATTENDED THE 1950 SPRING MEETING IN WASHINGTON, D. C., APRIL 12–14, 1950, AS GUESTS OF THE OLD GUARD COMMITTEE

(*Left to right, front row:* Edwin P. Nye, William C. Franklin, W. P. Wier, Jr. *Left to right, back row:* William J. Helvig, Lindon E. Saline, W. R. Stewart, Robert E. Coates.)

reading the literature" was not enough, he declared. To get something out of the Society and to make the Society a success, one must take an active part in Society affairs and one of the first things a man could do was to become active in his local Section.

He concluded by saying that the engineers should rise to the occasion and discharge their civic responsibilities. From observations made as he had traveled around the country, he believed that they were doing so.

Mr. Moll then introduced William F. Ryan, Fellow ASME, vice-president in charge of engineering, Stone and Webster Engineering Corporation, Boston, Mass., who spoke on professional development.

Mr. Ryan read the following extract from the Report of the Committee on Professional Recognition of the Engineers' Council for Professional Development, 1945, to clarify what he had in mind when he spoke of a profession.

Attributes of a Profession and Its Practitioners

Of a Profession:

1 It must satisfy an indispensable and beneficial social need.

2 Its work must require the exercise of discretion and judgment and not be subject to standardization.

3 It is a type of activity conducted upon a high intellectual plane: (*a*) its knowledge and skills are not common possessions of the general public; they are the results of tested research and experience and are acquired through a special discipline of education and practice; (*b*) engineering requires a body of distinctive knowledge (science) and art (skill).

4 It must have group consciousness for the promotion of technical knowledge and professional ideals and for rendering social services.

5 It should have legal status and must require well-formulated standards of admission.

Professional Practitioners:

1 They must have a service motive, sharing their advances in knowledge, guarding their professional integrity and ideals, and tendering gratuitous public service in addition to that engaged by clients.

2 They must recognize their obligations to society and to other practitioners by living up to established and accepted codes of conduct.

3 They must assume relations of confidence and accept individual responsibility.

4 They should be members of professional groups and they should carry their part of the responsibility of advancing professional knowledge, ideals, and practice.

Mr. Ryan went over this statement step-by-step and pointed out its salient features. Engineers might have these ideals in mind, he said, but they were not acting on them. Junior members should ask themselves what they expected the ASME to do with respect to unity of the profession and then make their thinking known to the Society. There was considerable talking as to what should be done, he declared, but when action was required, the volume of talk was not proportional to the final activity. An example of this was to be found in the code of ethics. It had taken ECPD 17 years to compile and edit an acceptable "Code of Ethics for Engineers," and now that this code was in existence we should ask ourselves to what degree we have accepted it. Mr. Ryan pointed out that an unduplicated list of members of all the engineering societies would have 175,000 names on it. In the last census 400,000 persons designated their profession as engineering. The two figures indicate that more than half the persons who consider themselves as members of the engineering profession are not even paying dues to any society for the advancement of their profession.

He said that the present group of junior members was doing well, perhaps better than their elders, and expressed high hopes for the future.

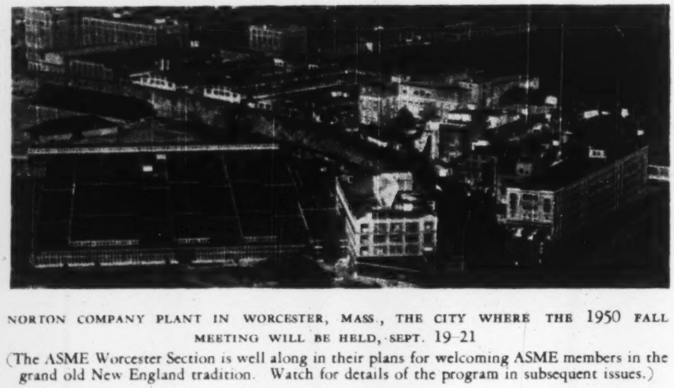
One Must Give to Receive

At the conclusion of Mr. Ryan's talk the meeting was opened to general discussion. Several of the men who were guests of the Old Guard were called upon for a few comments. During the discussion, President Cunningham suggested a thought-provoking questionnaire containing such questions as: What are my civic responsibilities? What am I doing about shouldering these responsibilities? Am I doing my share of church work?

It was pointed out in discussion that the National Junior Committee was trying to promote more activity on the part of junior members and not as a separate group.

In commenting on professional recognition, C. E. Davies, secretary ASME, said, "If it isn't in your heart, all the legislation in the world won't get the prestige for you."

Reported by William P. Wier, Jr.,
Jun. ASME, Rochester Section



NORTON COMPANY PLANT IN WORCESTER, MASS., THE CITY WHERE THE 1950 FALL MEETING WILL BE HELD, SEPT. 19–21

(The ASME Worcester Section is well along in their plans for welcoming ASME members in the grand old New England tradition. Watch for details of the program in subsequent issues.)

ASME Calendar

of Coming Events

June 12–16
ASME Oil and Gas Power Division Conference, Lord Baltimore Hotel, Baltimore, Md.
(*Final date for submitting papers was Feb. 1, 1950*)

June 19–23
ASME Semi-Annual Meeting, Hotel Statler, St. Louis, Mo.
(*Final date for submitting papers was Feb. 1, 1950*)

June 22–24
ASME Applied Mechanics Division Conference, Purdue University, Lafayette, Ind.
(*Final date for submitting papers was Feb. 1, 1950*)

Sept. 18–22
ASME Instruments and Regulators Division Conference, Municipal Auditorium, Buffalo, N. Y.
(*Final date for submitting papers was May 1, 1950*)

Sept. 19–21
ASME Fall Meeting, Hotel Sheraton, Worcester, Mass.
(*Final date for submitting papers was May 1, 1950*)

Sept. 25–28
Petroleum Mechanical Engineering Conference, Hotel Roosevelt, New Orleans, La.
(*Final date for submitting papers was May 1, 1950*)

Oct. 23–25
ASME Fuels Division Conference, Hotel Statler, Cleveland, Ohio
(*Final date for submitting papers—July 1, 1950*)

Nov. 26–Dec. 1
ASME Annual Meeting, Hotel Statler, New York, N. Y.
(*Final date for submitting papers—Aug. 1, 1950*)

April 2–5, 1951
ASME Spring Meeting, Hotel Atlanta Biltmore, Atlanta, Ga.
(*Final date for submitting papers—Dec. 1, 1950*)

April 17–19, 1951
ASME Process Industries Conference, Baltimore, Md.
(*Final date for submitting papers—Dec. 1, 1950*)

June 18–22, 1951
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(*Final date for submitting papers—Feb. 1, 1951*)

(*For Meetings of Other Societies see page 519*)

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph Street

Detroit
100 Farnsworth Ave

San Francisco
57 Post Street

MEN AVAILABLE[1]

Sales Engineer, trainee, 21, single, Tau Beta Pi. June graduate, BSME. Summer experience in assembling Diesel engines. Desires training position in technical sales. Travel or relocate. Me-706.

Recent Graduate, 21, BME, single. Summer experience in boilerhouse-instrument maintenance. Desires trainee or junior-engineer position in power plant or instrument industry. Will relocate. Available June. Me-707.

Industrial Engineer, materials-handling, warehouse-management, and shop experience. Desires assistant to executive spot with a future. 29, married. Will relocate. Me-708.

Mechanical Engineer, 25, family, MS, M.I.T., June, 1950. Pi Tau Sigma, currently research assistant. One year's experience drafting, design. Prefers research, development, testing. Excellent training, heat transfer, thermodynamics, stress analysis, plasticity. Me-709.

Plant or Maintenance Engineer, 31, married, experienced in manufacturing plants (building materials), involving plant engineering, design, administration, master mechanic, stores, production-shift foreman, construction, estimates, costs, layouts, piping, and maintenance. Will work toward supervisory position. Available on two weeks' notice. Prefers South or West. Me-710-489-D-6.

Engineering and Production Manager, 43, married, first-class training and experience in product development and research plus experience in manufacturing using many materials. Business and personnel training, PhD., registered civil and mechanical engineer. Available in two weeks. Prefers Calif. Me-700-456-D-3.

Methods Engineer, mechanical graduate, 10 years' experience, including extensive development lower-cost production methods, motion study, assembly-fixture design, machine and workplace layout, preparation of savings, estimates and process sheets. Me-712.

Mechanical Engineer, female, BME, Cornell, 1947. One year's experience. Stress analysis and fire-control computers. Desires employment suitable to background in Boston area. Me-713.

Mechanical Engineer, 30, BS. Three years' diversified employment as student engineer. Three years in navy steam-power plant as senior watch officer. In charge of sixty men and six officers. Four years as assistant professor of heat, power, and fluid courses. Charge of these courses. Desires position as plant engineer or equivalent. Me-714.

Recent Graduate, 25, single, veteran, BME, IE. Time-study and methods experience. Desires trainee or junior-engineer position. Prefers production or industrial engineering. Relocate or travel. Me-715.

Mechanical Engineer, four and a half years' precollege aircraft-maintenance experience. BME, 26. University of Minnesota, December, 1949. Me-716.

Mechanical-Engineering Graduate, June, 1950, Army veteran, 26, married, BSME, University of Maryland. Desires any position in mechanical-engineering field with a future. Relocate anywhere in Northeast U. S. Me-717.

Mechanical Engineer, 29, master's degree. Desires administrative position with small or medium-sized concern. Three years' teaching. Three and a half years in industry developing and testing automatic and semiautomatic machinery. Presently employed. Me-718.

Sales Manager, 29, married, ME. Now employed sales manager small manufacturer. Would like to manage district sales office with opportunity for development. Prefers medium or large company. Relocate in East or Midwest. Me-719.

Junior Industrial Engineer, 23, single, BAdE, 1949. Industrial engineering, production, and business-office experience. Fully qualified for position as trainee in industrial engineering or manufacturing. Will locate anywhere or travel. Me-720.

Quality-Control Engineer, 30, four years' experience, inspection, test, statistical quality control in light and heavy metalworking. Four years' additional experience in time study, methods, and plant layout in heavy industry. Me-721.

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[1] All men listed hold some form of ASME membership.

Air-Conditioning Engineer, 30, married, two years' experience air conditioning. Survey, design and layout, cost estimating, purchasing and installation supervision. Desires responsible position with air-conditioning contractor or consulting engineer. Sales or design. Prefers Pacific Coast or Midwest. Me-722-481-D-18.

POSITIONS AVAILABLE

Sales Manager, 40–50, mechanical or electrical graduate, electronic manufacturing, medical-equipment sales, promotion, and advertising, including 10 years or more supervisory and administrative experience, to take charge of domestic and foreign sales. Speak Spanish. Heavy selling experience, preferably in South America. $10,000 plus bonus. Midwest. Y-3466.

Director of Research and Engineering, development work in the fields of engine-control devices and navigational equipment; for research and development of optical devices of all degrees of complexity requiring computation and mounting of optics, mechanical devices of all degrees of complexity, and electronic devices, including radar components, but not including complete radar systems. Direct contract development projects for the Armed Forces on a basis of compliance with estimates of cost, time, and specified performance; and direct the development of projects sponsored by the company. Occasional traveling. $15,000–$20,000. New York Metropolitan area. Y-3468.

Project Engineer, mechanical degree, experience in designing and developing various types of mechanical equipment, preferably in hydraulics. Knowledge of equipment needs in industries using high pressures for metalworking. Responsible for developing new machinery applications; adapting customer end-use requirements to production models; and initiating and carrying through basic research, survey, and development programs for diversifying the product lines, for manufacturer of heavy hydraulic machinery. $10,000–$15,000. Northern New Jersey. Y-3501.

Steel Buyer, not over 45, preferably mechanical graduate, at least 10 years' experience in the purchase of all types of process steel. $10,000. New York, N. Y. Y-3531.

Mechanical Engineer Designer, 35–45, to take complete charge of the mechanical design of an architect-consultant specializing in hospitals, schools, apartment, and commercial buildings. Extensive experience in plumbing, heating, and air conditioning. $7200–$9000. South. Y-3536.

Assistant Plant Manager, mechanical engineer, 40–45, graduate, heavy machinery and sheet-metal experience, to be responsible for machine shop, assembly, and redesign of drying and solvent-reclaiming equipment for small company. $5000 plus bonus. New England. Y-3575.

Engineers. (*a*) Chief mechanical engineer, mechanical graduate, or possibly chemical, preferably with license, over 40, with minimum of 10 years' experience in the design of process equipment for industrial and chemical plants. Good administrator. $7800–$8400. (*b*) Mechanical engineer, minimum of 10 to 15 years' experience in heating, ventilating, and air conditioning for industrial or chemical plant. $7200–$7800. New York, N. Y. Y-3585.

Sales Mechanical Engineer, 30–45, two to three years' experience selling, preferably pumps (center, rotary, and screw) and chemical-production equipment (pressure vessels, agitators, vertical and horizontal ball-and-pebble mills, ribbon mixers, combination blenders) to heavy industry, paint, oil, food, chemical, etc. Sell custom-built installations direct to users. Car required. $4800 plus expenses and incentive. Ill. R-6388.

Maintenance Engineer, for a small institution, 35–42, mechanical background, experienced with oil-steam plant (high and low-pressure) air conditioning, water softener, septic tank, heating and ventilating; able to make and supervise maintenance repairs (plumbing, carpentry, electrical, mechanical, painting) and supervise grounds for well-equipped, newly-constructed installation. Four to six on staff. $3000, maintenance, five-room apartment, rent, heat, light, and laundry. Chicago area. R-6413.

Instructor, MME, some industrial background desirable instructing undergraduate freshman and sophomore years. Eventually take over department administration consisting of nine people for a state university. $4500. Midwest. R-6439.

Chief Engineer, about 40, mechanical, 10 to 20 years' experience with industrial-furnace installations, engineering department and field. Knowledge of structural, mechanical, and installation requirements; direct and co-ordinate office and field problems; contact clients and interpret clients' requirements to engineering department, and engineering-department information to clients and subcontractors. Knowledge of refractories desirable for an industrial company. $8400–$9600. Headquarters, Ill. R-6463(*a*).

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after June 25, 1950, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

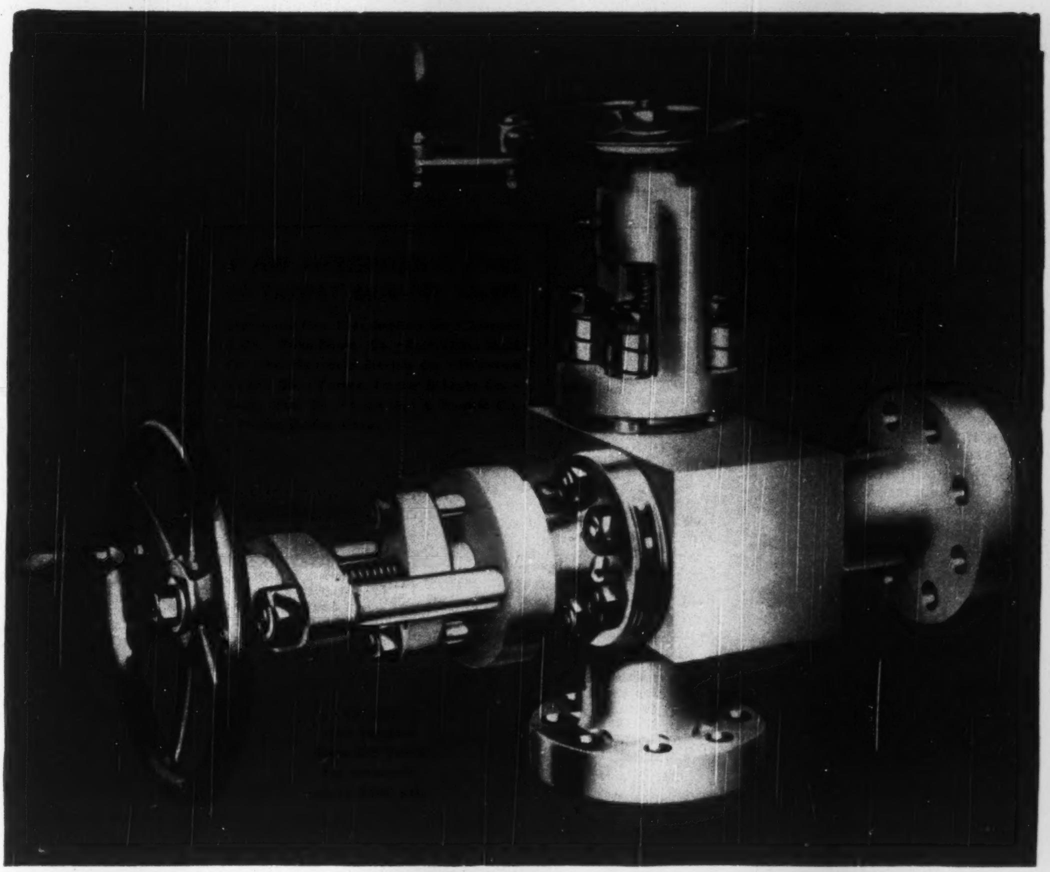
R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

Alberti, Frank, Seattle, Wash.
Arthur, Albert K., Los Angeles, Calif.
Bahn, Gilbert S., Malverne, N. Y.
Barclay, Stanton DeWitt, Cambridge, Mass. (Rt & T)
Becker, Melvin, Baltimore, Md.
Belyea, Arthur R., New York, N. Y.
Bowers, Frank J., Youngstown, Ohio
Bradley, John L., South Charleston, W. Va.
Brasfield, James E., Trenton, Ga.
Burris, Roy E., Jr., Schenectady, N. Y.
Calhoun, D. C., Charleston, W. Va.
Cantieri, W. F., Lancaster, Ohio
Cass, Charles H., E. Hartford, Conn.
Colley, Joseph F., Savannah, Ga.
Cook, Robert G., Jr., Lancaster, Pa.
Crabb, Randall E., Detroit, Mich.
Cummings, Donald Earl, Woodriver, Ill.
Davis, Wendell R., Sheboygan, Wis.
Dolce, Sebastian J., Elmhurst, N. Y.
Eigenbrot, Albert L., New York, N. Y.
Elliott, W. S., Rego Park, N. Y. (Rt & T)
Fathauer, J. E., Cleveland, Ohio
Feldbush, H. A., Short Hills, N. J. (Rt & T)
Frakes, William R., Ann Arbor, Mich.
Fuller, F. L., Amityville, N. Y. (Rt & T)
Garmezy, Robert Harper, Detroit, Mich.
Garr, Donald Emerson, Schenectady, N. Y.
Garrigues, Walter D., Massillon, Ohio
Gaskill, W. C., New York, N. Y.
Gerin, M., Montreal, Que., Can.
Ginzburg, Nicola, Claymont, Del.
Goklany, Murli W., Philadelphia, Pa.
Greene, Robert D., Denville, N. J.
Hackbart, Reuben J., La Crosse, Wis.
Haddock, William S., Jr., Warren, Pa.
Hand, Carl A., Moline, Ill.
Hansen, Elmer K., Cleveland, Ohio
Hansen, J. P., Hampton, Ga.
Hartshorn, Floyd J., Jr., Milwaukee, Wis.
Hehn, Lester C., Port Washington, N. Y.
Hemak, Chester Walter, Chicago, Ill.
Holt, Marshall, New Kensington, Pa.
Kabelac, Otakar W., Washington, D. C.
Karol, Paul, Newton Centre, Mass.
Karr, H. M., San Francisco, Calif.
Kascal, W. F., Dallas, Texas
Kearns, Earl E., Erie, Pa.
Keim, Jonathan R., Philadelphia, Pa.
King, Charles D., Moscow, Idaho
Klein, Roy L., Dallas, Texas
Koontz, Hall A., Washington, D. C.
Lafferty, R. J., Los Angeles, Calif.
Landreth, Robert Nelson, Vienna, Va.
LaPierre, Cramer Wilson, Riverside, Conn.
Lederer, A. C., Jr., Kingsville, Texas
Lee, Charles H., Jr., Berkeley, Calif.
Lester, Joseph Thomas, Palmer, Mass.
Levy, Nathan J., Newport News, Va.
Longmuir, G. M., Dansville, N. Y.
Mack-Forlist, D. Mark, Baltimore, Md.
Mapes, W. M., N. Barberton, Ohio
Mariy, H., Benha, Egypt
Martin, Eugene J., Bayside, N. Y.
May, Robert L., Alliance, Ohio
McCready, Ross B., Alliance, Ohio
McCully, L. B., E. Pittsburgh, Pa.

(*ASME News continued on page 532*)



TIGHT! STRONG! for even toughest blow-down requirements

The Yarway Unit Tandem Blow-Off Valve meets the most demanding requirements for boiler blow-down or drain service.

It's drop-tight—and rugged enough to withstand the severe punishment of regular or emergency blow-down under pressure, or periodic acid wash.

Two Yarway Stellite-Seat Hard-Seat Valves or a Hard-Seat (blowing) and Seatless (sealing) Valve are combined in a one-piece forged-steel body. Designed for pressures up to 2500 psi.

It is significant that more than 4 out of 5 high pressure boiler plants use Yarway Blow-Off Valves.

For more facts, see Yarway Bulletin B-432.

YARNALL-WARING COMPANY
108 Mermaid Avenue, Philadelphia 18, Pa.
Branch Offices in Principal Cities

YARWAY **BLOW-OFF VALVES**

McCune, Wesley E., Hickman Mills, Mo.
McLaughlin, W. E., Rapid City, S. Dak.
McMillan, J. A., Sarnia, Ont., Can.
Mission, George W., La Grange Park, Ill.
More, Antonio, Houston, Texas
Morse, Roger J., Bloomfield, N. J.
Moses, Alfred Tennyson, Austin, Texas
Nagel, Felix Ernst, Schenectady, N. Y.
Navarro, Jorge M., Rancagua, Chile
Nefcy, Girard, Detroit, Mich.
Neufeld, Saul, Brooklyn, N. Y.
O'Neal, G. E., Asheville, N. C.
Owens, James J., Alliance, Ohio
Peabody, Raymond C., Waterford, Conn.
Pitkin, Richard G., Westport, Conn. (Rt & T)
Potosky, George John, Warren, Ohio
Rasmussen, Andrew A., Houston, Texas
Rees, James G., Chicago, Ill.
Reiss, Donald E., St. Louis Park, Minn.
Ridgway, William Charles, Swissvale, Pa.
Roberts, Ralph R., Fair Lawn, N. J.
Saltz, Martin H., E. Meadow, N. Y.
Sanborn, William Royal, Swarthmore, Pa.
Scott, Russell Cecil, Richmond, Va.
Seelig, Albert F., Jr., St. Louis, Mo.
Seufer, A. Charles, Quincy, Ill.
Stephenson, Eben A., Chattanooga, Tenn.
Stephenson, O. W., Jr., New Orleans, La.
Thompson, Harry F., Phoenix, Ariz.
Touchton, Fred H., Baltimore, Md.
Tschudy, Donald B., Canton, Ohio
Vail, Horace E., Dallas, Texas
Van Vleet, John Mitchell, Wauwatosa, Wis.
Ward, Edward E., Birmingham, England
Welch, Kenneth B., West Bend, Wis.
Whitlow, Lyman B., Picayune, Miss.
Wiseman, Harry A. B., State College, Pa.
Wrenn, John M., Bellerose, N. Y.
Yates, Jack Hamilton, Canton, Ohio
Yee, Dickman, St. Louis, Mo.
Zapp, Gerard J., Rosedale, N. Y.

CHANGE IN GRADING

Transfers to Member and Associate

Butler, James C., Detroit, Mich.
Eggebrecht, Edward T., Jr., Hammond, Ind.
El Alaily, Mohamed Mostafa, Abbasiah, Cairo, Egypt
Elkins, Douglas A., Salt Lake City, Utah
Fransson, Karl E., Canton Center, Conn.
Gessner, Frank R., Jr., Annapolis, Md.
Hamilton, D. C., Jr., Lafayette, Ind.
Hamilton, Earl B., Dayton, Ohio
Lamm, Earl S., W. Lafayette, Ind.
Neumunz, George M., River Edge, N. J.
Vander Velde, M. H., Chicago, Ill.

Transfers from Student Member to Junior 1526

Obituaries

Walter Neal Cargill (1877–1949)

Walter N. Cargill, sales engineer, died Nov. 11, 1949. Born, Liberty, Me., Oct. 5, 1877. Education, BME, University of Maine, 1900. Mem. ASME, 1912. Survived by wife.

Paul Sayre Carnes (1902–1949)

Paul S. Carnes, consulting engineer, Los Angeles, Calif., died Dec. 25, 1949. Born, Anniston, Ala., Jan. 20, 1902. Parents, Percy T. and Annie N. Carnes. Education, BS, Montana State College, 1925; BSME, University of Southern California, 1940. Married Wilma Paul, 1932; children, Judith Ann and Linda Jean. Jun. ASME, 1940; Mem. ASME, 1943.

Edward Smith Cole (1871–1950)

Edward S. Cole, hydraulic engineer, who retired in 1947 as president, Pitometer Co., New York, N. Y., died March 18, 1950, at his home in Upper Montclair, N. J. Born, Washington, D. C., Dec. 29, 1871. Parents, John Adams and Julia Mead (Alvord) Cole. Education, ME, Cornell University, 1894. Married Mary W. Rockwell, 1901. Jun. ASME, 1897; Mem. ASME, 1906; Fellow ASME, 1941. Received the Worcester Reed Warner Medal, 1948. Served the Society for many years on the Research Committee on Fluid Meters. In 1940 the Cole Pitometer Method was adapted for inclusion in the Power Test Code for Hydraulic Prime Movers. Survived by wife, a daughter, Mrs. William E. Jordon, and two sons, E. Shaw and John Rockwell; and a sister, Mrs. D. J. Fleming.

John Tener Deutsch (1894–1950)

John T. Deutsch, president, The Allen-Sherman-Hoff Co., Philadelphia, Pa., died in Wayne, Pa., March 9, 1950. Born, Danville, Pa., Sept. 25, 1894. Parents, William L. and Mary B. Deutsch. Education, BS, Pennsylvania State College, 1916. Married Mary M. Rogers, 1921. Mem. ASME, 1942. Survived by wife and son, William R., both of Ithan, Pa.

Raymond Alfred Flagg (1914–1950)

Raymond A. Flagg, mechanical engineer, Standard Dredging Corp., New York, N. Y., died Feb. 23, 1950. Born, Detroit, Mich., Oct. 22, 1914. Education, BS, Duke University, 1947. Married Arden Crandall, 1938. Jun. ASME, 1949. Survived by wife and three daughters, Toni Robin, Julianne, and Holly Rae.

George Frederic Gebhardt (1874–1950)

George F. Gebhardt, professor emeritus, former director of the mechanical-engineering department, Illinois Institute of Technology, died in Miami, Fla., March 22, 1950. Born, Salt Lake City, Utah, March 1, 1874. Parents, Henry Andrew and Wilhelmina (Schuster) Gebhardt. Education, AB, 1895; MS, 1897, Knox College; ME, Cornell University, 1897. Married Edith M. Jensen, 1914. Mem. ASME, 1904. Author, Combustion, 1925; Steam Power Plant Engineering, 1927. Survived by wife and two daughters, Mrs. Mildred Thompson, Owensboro, Ky., and Mrs. Sally E. Clutter, Miami, Fla.

Frederick Arthur Goetze (1870–1950)

Frederick A. Goetze, treasurer of Columbia University for 32 years before he retired in 1948, died March 7, 1950, in Venice, Fla. Born, Jersey City, N. J., April 17, 1870. Parents, Frederick A. and Sarah C. (Gee) Goetze. Education, MS, Columbia School of Mines, 1895; Hon. DS, 1929. Married May L. Martin, 1896. Jun. ASME, 1895; Mem. ASME, 1900. Mr. Goetze negotiated the 87-year lease, Oct. 1, 1928, under which Columbia rented its property to J. D. Rockefeller, Jr., for the construction of the present Rockefeller Center. Survived by three children, Mrs. Marjorie Campbell, New Canaan, Conn.; Dr. Dorothy Goetze, Hot Springs, Ark.; and Richard B., Old Greenwich, Conn.

Arthur Julius Herschmann (1873–1950)

Arthur J. Herschmann, mechanical engineer, export manager since 1922, Parker-Kalon Corp., New York, N. Y., died March 10, 1950. Born, Bruenn, then a part of Austria, May 31, 1873. Parents, Albert and Louise Elizabeth Herschmann. Education, ME, Pilsen (Austria) Engineering College, 1891. Naturalized, New York, N. Y., 1911. Married Maude M. Labberton, 1928 (died March 7, 1950). Assoc. ASME, 1900; Mem. ASME, 1905.

Henry Ellis Hughes (1881–1950)

Henry E. Hughes, retired engineer, died at his home in Rutherford, N. J., Feb. 28, 1950. Born, Washington, D. C., March 17, 1881. Parents, James and Mary Rebecca (Cooper) Hughes. Education, BSEE, George Washington University, 1904. Married Dora M. Morrell, 1911 (died 1937). Married 2nd, Charlotte O'Day. Mem. ASME, 1916. Survived by wife and adopted son, William H.; and three sisters, Susan C. Hughes, Washington, D. C.; Mrs. Mary H. Morehouse, Bellafontaine, Ohio, and Mrs. Robert H. Scott, Gary, Ind.

Ivan Titus Jacks (1888–1950)

Ivan T. Jacks, vice-president and general manager, Societe Anonyne Hellenique Des Eaux Des Villes D'Athenes, Piree, et Enviv, Athens, Greece, died at his home in Athens on Feb. 14, 1950. Born, Lebanon, Ind., Feb. 3, 1888. Education, University of Tennessee. Married Reba Nathan. Married 2nd, Semeli Varda, 1947. Mem. ASME, 1944. Survived by wife.

Raymond Meserve Kellogg (1881–1950)

Raymond M. Kellogg, retired engineer, Consolidated Edison Company of New York for 46 years, died at his home in Mount Vernon, N. Y., Feb. 27, 1950. Born, New Haven, Conn., Feb. 15, 1881. Parents, Cyrus W. and Fannie (McLean) Kellogg. Education, PhB, Yale University, 1901. Married Grace Morgan Kline, 1906. Men. ASME, 1915. Survived by wife and son, William K.; and a brother, Harrison B. Kellogg.

Alexander Klemin (1888–1950)

Alexander Klemin, educator and authority on helicopters, died at his home in Greenwich, Conn., March 13, 1950. Born, London, England, May 15, 1888. Parents, Albert and Dora (Clemens) Klemin. Education, BS, London University, 1909; MS, Massachusetts Institute of Technology, 1915; Hon. LLD, Kenyon College, 1934. Married Ethel Murton, 1921. Nationalized citizen, U. S., 1917. Winner of army and navy airplane-design competitions. Assoc-Mem. ASME, 1919; Mem. ASME, 1921. Served the Society as chairman, executive committee, Aeronautics Division; Committee on Industrial Aerodynamics, and many other committees dealing with aviation. Author of several books on aeronautics. Survived by wife and daughter, Diana.

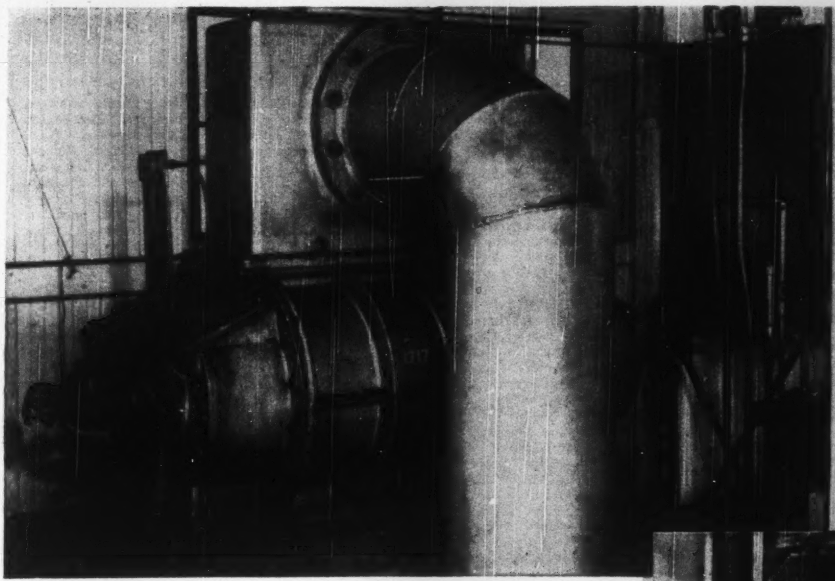
Jack W. R. Lemery (1912–1950)

Jack W. R. Lemery, partner, Lambert and Lemery, Oakland, Calif., died Feb. 22, 1950. Born, Oakland, Calif., Nov. 21, 1912. Parents, Frederick Arnold and Margaret Arrietta Lemery. Education, BS, University of California, 1934. Married Zilpha Taylor, 1936. Jun. ASME, 1935. Survived by wife.

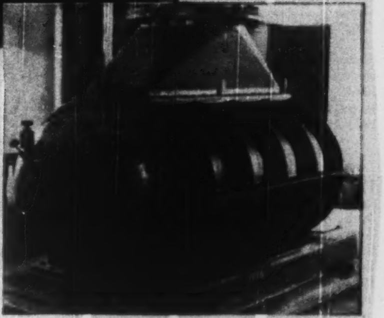
Grant Wyman Lillie (1868–1950)

Grant W. Lillie, retired sales engineer, died in Salt Lake City, Utah, Jan. 16, 1950. Born, Omaha, Neb., April 3, 1868. Parents. Jerome Aikens and Caroline (Parmeter) Lillie.

(*ASME News continued on page 534*)



Installed in 1926, this unit, still in service, attests to the long-time, accurate performance of R-C Meters.



This R-C Meter, with capacity of 317,000 cfh, replaced the "old-timer" above, now transferred to other duties.

NO PENSION

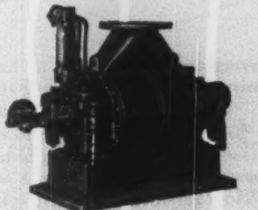
for this old-timer even after 23 years

Accurate and dependable as always, this 23-year-old Roots-Connersville Meter still performs faithfully. No retirement for this veteran! Because new demands called for higher capacity, it has been transferred to another job in the same plant. Its old duties have been taken on by a new R-C unit, purchased because of fine performance of this old-timer.

That's a common history of R-C Meters. They're built to measure accurately, and keep on doing it, year after year. Simple design, finely machined measuring surfaces and other important refinements account for their ability to measure gas accurately and unfailingly, almost indefinitely.

With 31 standard sizes and capacities from 4,000 to 1,000,000 cfh, R-C Meters meet the needs of most manufacturing and industrial applications. Write for Bulletin 40-B-14 or tell us your specific requirements.

ROOTS-CONNERSVILLE BLOWER CORPORATION
506 Michigan Avenue, Connersville, Indiana



Typical small capacity R-C Meter for low and medium pressures.

ROOTS-CONNERSVILLE
ONE OF THE DRESSER INDUSTRIES

BLOWER BUILDERS
SINCE 1854

DOING ONE THING WELL
FOR ALMOST A CENTURY

Education, high-school graduate; ICS. Married Mary Emma Mitchell, 1890 (died 1949). Jun. ASME, 1901; Mem. ASME, 1921. Survived by five children, Mrs. Judith L. MacArthur, Sherman M., James J., all of Salt Lake City, Utah; Herbert P., Berkeley, Calif., Walter T., San Marino, Calif.

Halstead Henry Mills (1880–1950?)

HALSTEAD H. MILLS, retired safety engineer, whose death was recently reported to the Society, was born in Plainfield, Ind., Oct. 26, 1880. Parents, William and Olive Mills. Education, Central Academy. Married Katherine Vestal, 1903; children, Jeannette and Georgia. Assoc. ASME, 1922.

George Kerr Miltenberger (1889–1950)

GEORGE K. MILTENBERGER, general superintendent; electrical operations, Union Electric Company of Missouri, St. Louis, Mo., died March 6, 1950. Born, St. Louis, Aug. 10, 1889. Education, ME, Cornell University, 1911. Jun. ASME, 1913; Mem. ASME, 1925.

Fred Burton Orr (1887–1950)

FRED B. ORR, formerly chief engineer, Illinois Maintenance Co., Chicago, Ill., died March 5, 1950, at his home in Los Angeles, Calif. Born, West Middleton, Ind., Feb. 9, 1887. Parents, William Henry and Mary Florence Orr. Education, BSME, Purdue University, 1907. Married Ida M. Fischer, 1918. Mem. ASME, 1921. Served the Society as secretary-treasurer of the Chicago Section, 1923–1944. Survived by wife.

James Russell Putnam (1880–1950)

JAMES R. PUTNAM, director of engineering, The U. S. Time Corporation, Waterbury, Conn., died at Westfield, N. J., Jan. 16, 1950. Born, Boston, Mass., June 30, 1880. Parents, George E. B. and Ellen H. (Whitney) Putnam. Education, BSME, Massachusetts Institute of Technology, 1901. Married Alice Dempsey, 1904 (died 1949). Mem. ASME, 1913. Served on Executive Committee, Waterbury Section; chairman, two years; secretary, seven years. Held several patents relative to clocks. Survived by two children, Mabel P. (Mrs. Harry R.) Lange, Waterbury, Conn., and George C., Westfield, N. J.

Willard Glidden Ransom (1875–1950)

WILLARD G. RANSOM, partner, Cook and Ransom, contractors, Ottawa, Kan., died March 10, 1950, at his home in Ransomville, Kan. Born, Clinton, Kan., Feb. 17, 1875. Parents, James H. and Enice (Glidden) Ransom. Education, ME, Cornell University, 1899; MME, Columbia University, 1906. Married Edna Lescher, 1911. Mem. ASME, 1917. Survived by wife, three sons, J. Frederick, Mem. ASME, Denver, Colo.; Willard G., Jr., Ransomville, Kan.; John P., Topeka, Kan.; a daughter, Mrs. Donald Ward, Schenectady, N. Y.; and seven grandchildren.

Thomas Ray (1866–1950)

THOMAS RAY, consulting mechanical engineer and president, Manistee Iron Works Co., Manistee, Mich., died Feb. 1, 1950. Born, Dukinfield, Cheshire, England, May 27, 1866. Parents, George R. and Mary (Riley) Ray. Married Estella Cook, 1893. Education, public schools, Grand Rapids, Mich. Pioneered use of and held patents on multiple-effect vacuum evaporators in the salt industry. Mem. ASME, 1920. Survived by wife, a daughter, Mrs. W. Arthur Tobey; and a son, Donald C.

Harold Anthony Richmond (1871–1948)

HAROLD A. RICHMOND, chairman, board of directors, and treasurer, General Abrasive Co., Niagara Falls, N. Y., died at Memorial Hospital, New York, N. Y., April 8, 1948. Born, Brooklyn, N. Y., Jan. 3, 1871. Parents, Walter and Julia C. (Anthony) Richmond. Education, BS, Massachusetts Institute of Technology, 1893. Married Evelyn L. Kimball, 1896. Married 2nd, May C. Nicholson, 1923; children, Margaret, Harold A., Jr., Gerald A., Jun. ASME, 1898; Mem. ASME, 1921. Survived by wife and son, Gerald A.

James R. Robinson (1865–1950)

JAMES R. ROBINSON, head of the Robinson Ventilating Co., Zelienople, Pa., died March 2, 1950, at the Ellwood City Hospital. Born, Monongahela, Pa., Aug. 17, 1865. Education, Cornell University. His wife died last year. Mem. ASME, 1905. Author of "Practical Mine Ventilation." Survived by two daughters, Mrs. James L. Henderson, Sr., and Mrs. James O. Dodds, both of Zelienople; four sons, P. W., and R. R., Zelienople; L. R., Dormant, Pa., and M. R., Gilroy, Calif.; 11 grandchildren and nine great-grandchildren.

Frederick G. Schranz (1880–1950)

FREDERICK G. SCHRANZ, consulting engineer and former vice-president, Baldwin-Southwark Division, Baldwin Locomotive Works, died March 5, 1950, at University of Pennsylvania Hospital, Philadelphia, Pa. Born, Vienna, Austria, April 8, 1880. Education, ME, University of Mittweida, Germany, 1902. Mem. ASME, 1916. Survived by wife, Johanna K., and two daughters, Mrs. Joseph I. Borneman and Mrs. Charles M. Wall.

Henry Herman Troger (1904–1950)

HENRY H. TROGER, chief production planner, Federal Shipbuilding and Dry Dock Co., Kearny, N. J., died at his home in Raritan, N. J., March 27, 1950. Born, Brooklyn, N. Y., Jan. 11, 1904. Parents, Henry H. and Helena Troger. Education, BSME, Rutgers University, 1926; ME, 1929. Married Anna Mae Boylan, 1927. Jun. ASME, 1927; Mem. ASME, 1946. Survived by wife and son, Henry H., 3rd.

Gustave Adolphe Ungar (1883–1950)

GUSTAVE A. UNGAR, consulting mechanical engineer, Equi-Flow Corp., New York, N. Y., died March 30, 1950, at New Rochelle (N. Y.) Hospital. Born, Vienna, Austria, Feb. 2, 1883. Parents, Simon and Bertha Ungar. Education, ME, Vienna Technical University, 1904. Naturalized, Hartford, Conn., 1919. Married Irma Salomon, 1910. Mem. ASME, 1939. Survived by wife and two daughters, Carla and Mrs. Rhoda Merriman.

Earl Parker Webster (1891–1950)

EARL P. WEBSTER, mechanical engineer, National Biscuit Co., New York, N. Y., died March 9, 1950. Born, Bridgeport, Conn., Nov. 17, 1891. Parents, Edgar Parker and Bertha E. Webster. Education, Park Avenue Institute. Married Mary F. Tierney, 1917. Mem. ASME, 1943. Survived by wife and son, Edward Parker W.

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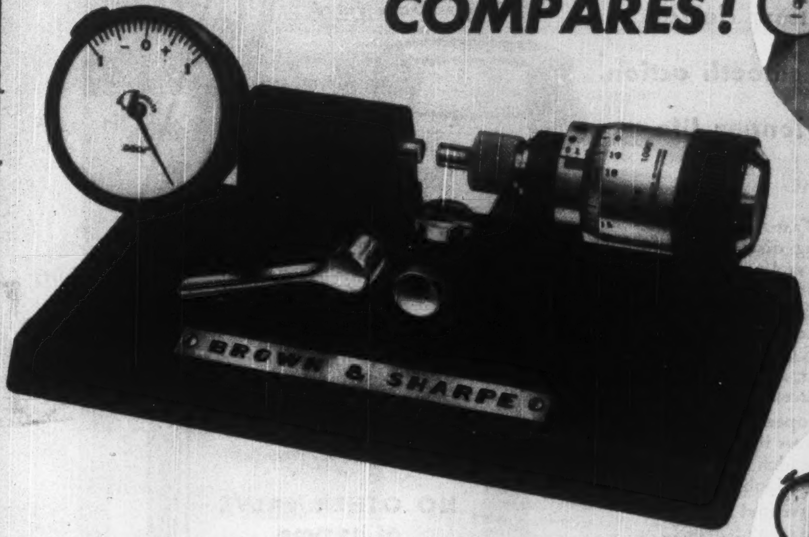
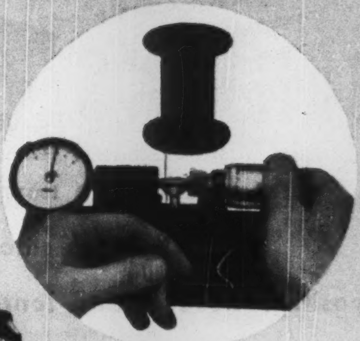
NOW! A BENCH MICROMETER *that both* *MEASURES and* COMPARES!





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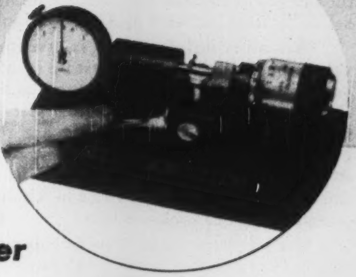
A finger operated lever is the only motion required for multiple inspection of duplicate parts.



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MEASURES to an accuracy of .0001″ over range of 0 to ½″. Reads directly from the thimble. Or, for fast setting and measuring, can be set to nearest thousandth and then read in increments of .0001″ on dial gage.

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Measuring surfaces of the No. 245 are tipped with tungsten-carbide for minimum wear. Anvil movement is in straight line — frictionless — with measuring surfaces parallel in all positions. Adjustable work support facilitates centering. Measuring pressure is constant and adjustable — factory-set at any pressure you specify, from 8 oz. to 2 lb.

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with an exclusive new design
that assures smooth action,
positive closure, and longer life

In the new Jenkins SWINGTITE Fast-Action Bronze Gate Valve, the exclusive rolling disc and guide track design lengthens valve life and assures maximum tightness as it prevents uneven wear of seating surfaces. As the valve is opened or closed, guide rims around the seating surfaces of discs roll freely over guide tracks cast in the body, distributing wear evenly, dislodging foreign matter, and providing a polishing action for seating surfaces.

The SWINGTITE can be opened or closed instantaneously and easily with less than a quarter turn of the malleable iron lever which activates the self-adjusting ball and socket type double disc.

Wherever full, free flow is essential . . . where valve opening or closing must be instantaneous . . . you will see more and more Jenkins SWINGTITE Bronze Gate Valves setting new standards of performance and endurance. They are recommended especially for such services as laundry machinery, dish-washing equipment, gasoline and fuel oil lines, fire extinguishing steam lines in kitchens, and dispensing lines to tanks or vats.

Get all the facts on the new Jenkins SWINGTITE. Find out how much smoother-operating, how much *longer-lasting* these fast-action Bronze Gate Valves can be when *Jenkins* builds them. Send for the new folder, Form No. 196, containing full details. Jenkins Bros., 100 Park Avenue, New York 17, N.Y. Jenkins Bros., Ltd., Montreal.

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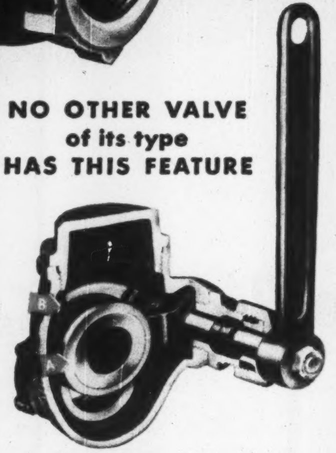

Notice the guide rims (A) of the discs which rotate freely on the guide tracks (B) cast in the body, as the valve opens or closes. This roller action provides a self-cleaning and polishing effect, and also distributes the wear, since the seating position of the discs changes with each closing. Rapid, uneven wear is prevented, and continuous tight closure assured.

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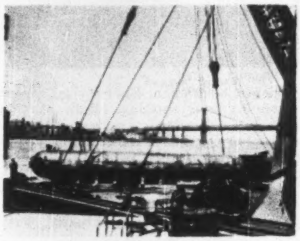
• *NEW EQUIPMENT*

116-Ton Steam Drum For World's Largest Boiler is Delivered by Babcock & Wilcox

The 116-ton steam drum for the world's largest boiler completed a 600-mile trek from The Babcock & Wilcox Co. plant in Barberton, Ohio where it was built, to the Hudson Avenue (Brooklyn) electric generating station of Consolidated Edision Co. of New York, Inc.

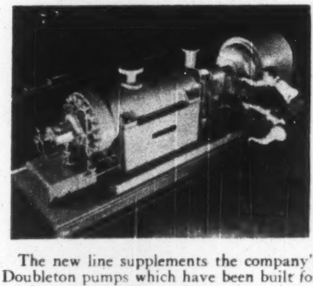


The 60-foot drum, which is six feet in diameter, was floated on a lighter from Greenville, N. J. around the Battery to the New York Naval Shipyard and then loaded on a trailer truck for the final stage of its trip. The journey from Barberton, Ohio to Greenville was made on three specially rigged flat cars over the Pennsylvania Railroad Line.

Because of the drum's size and the possibility that the trailer might not be able to negotiate corners on narrow streets, several trial runs were made to select a route from the shipyard to the Hudson Avenue station.

Barrel-Type Boiler Feed Pumps

A new single-suction, double-case, barrel-type boiler feed pump designed for higher efficiency and operation in the 1,200 to 2,500-pound pressure range has been announced by Allis-Chalmers Mfg. Co., Milwaukee.



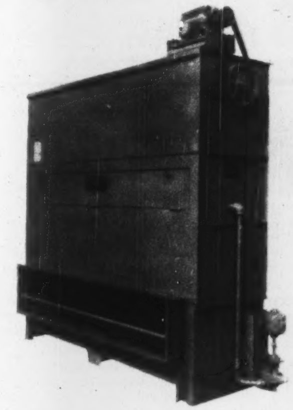
The new line supplements the company's Doubleton pumps which have been built for service up to 1,900 pounds at a capacity of 1,400 gpm with seven stages. It is based on exhaustive tests of various types of volutes, return passages and impeller types and arrangements.

The new unit has back-to-back impellers and radially balanced double volutes in a split inner casing. On the larger capacity pumps, the first stage employs two single suction impellers in parallel. These take one half the flow which gives full advantage of double suction impeller in the first stage and permits operation at low suction heads.

In addition to its high efficiency, the new pump offers the stability of a volute design, complete radial and axial balance and freedom from expansion in any direction as well as accessibility for maintenance. While the pump is intended primarily for boiler feed water, it can be used for other high pressure applications.

New Aeropass Refrigerant Gas Condenser

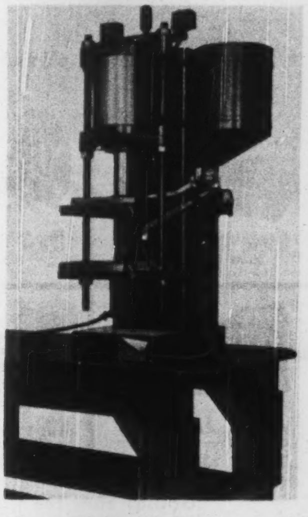
A new Aeropass refrigerant gas condenser is announced by the Niagara Blower Co. Designated as the 5800 series, the new condenser is designed especially for use where Freon is the refrigerant and for air conditioning and industrial refrigerating applications. The series consists of five standard units ranging in capacity from ten to fifty tons refrigeration at 105° F. Freon condensing temperature and 74° F. Atmospheric Wet Bulb Temperature.



The smallest unit has casing dimensions of 31" × 24" × 85¼" in height and the largest is 94" × 30" × 93¼" in height. Casing, fan and eliminator construction is galvanized steel. Condensing coils for Freon are copper tube, with copper fin or hot galvanized steel tube and fin. Weatherproof construction for outdoor installation is available. Operating on the evaporative principle, the condenser saves 95% of the condensing water required by the shell and tube condenser method and since it replaces both conventional condenser and cooling tower its first cost as well as operating cost is low. The manufacturer is the Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y.

Special Elmes Press Developed For New Alkyd Resins

A special line of molding presses, designed to handle the revolutionary new low-pressure, fast-setting alkyd resins to the fullest advantage, is announced by the Elmes Engineering Division of American Steel Foundries, 1150 Tennessee Avenue, Cincinnati 29, Ohio. In developing the new "Minimatic" (miniature-automatic) Presses, Elmes Engineers worked in close cooperation with a prominent manufacturer of the new mineral-filled molding compound.



Elmes "Minimatic" Presses are small in size, simple in design, and inexpensive. They are specifically designed for maximum flexibility of application and high-speed, low-cost production with a minimum investment. There is a choice of five cylinder capacities—3-ton and 6-ton for air application, and .6-ton, 1.2-ton, and 2.4-ton for hydraulic service. All cylinders are interchangeable in the basic frame. The basic press incorporates all the necessary controls for completely automatic, continuous operation or semi-automatic, single-cycle control where insert molding is done. Press operation is controlled by an exceptionally simple Elmes operating valve.

Continued on Page 42

Fig. 3450

For heavy duty, large capacity jobs . . .
Goulds double suction centrifugals

TYPE	USES	ADVANTAGES
Centrifugal, single stage double suction with horizontally split casing. Capacities: to 15,000 G.P.M. Heads: to 500 feet depending on capacity. Sizes: 2" to 16".	General water supply; water works; circulating and booster service; low pressure boiler feeding.	Rugged, heavy duty construction; may be dismantled without disturbing pipe connections. Made in bronze fitted, all iron, and all bronze constructions.

Other Examples of Goulds Complete Line

Fig. 3010—Cap. 5 to 100 G.P.M. Heads to 70 ft. Sizes 1", 1½", 2".

Fig. 3650—Cap. to 2000 G.P.M. Heads to 400 ft. Sizes 1" to 6".

Fig. 3105—Cap. 250 to 4500 G.P.M. Heads to 220 ft. Sizes 4" to 8".

Fig. 3648—Cap. to 35 G.P.M. Pressures to 190 lbs. Sizes ¼ H.P. to 5 H.P.

Fig. 3705—Stainless Steel—Cap. to 600 G.P.M. Heads to 200 ft. Sizes 1" to 3".

Fig. 3330—Cap. 40 to 2000 G.P.M. Heads to 3200 ft. Sizes 2" to 8".

Goulds Has The Right Pump For Your Job

The above are only six of the more than 180 types and sizes of pumps that Goulds makes. Pumps are our only business—have been for over 100 years.

The *right pump* for your job saves you money. Phone or write Pump Headquarters or your nearest Goulds representative for their recommendation on any pump job you may have.

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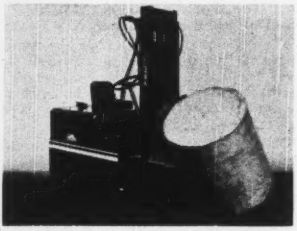
In the air cylinders, operation is double-acting. However, by use of a three-way operating valve with hydraulic cylinders, constant air pressure returns the cylinder upward, resulting in considerable power savings.

New bulletin, "Elmes Minimatic Molding Presses", gives full details and will be sent promptly on request.

Rotating Clamp Device Simplifies Handling Paper and Other Roll Materials

For faster and more efficient handling of paper and other roll materials, a rotating clamp device is offered by Clark Equipment Co. for use on all gas and electric carloader model fork-lift trucks with standard rated capacities of 3000 to 5000 pounds.



The new attachment has two basic actions—clamping and rotating. Rolls may be handled in either vertical or horizontal position, and changed from either position to the other. A roll can be rotated at uniform speed through 90 degrees. Both clamping and rotating actions are accomplished hydraulically; and a supplementary load accumulator, hydraulically actuated, serves to prevent loss of clamping pressure.

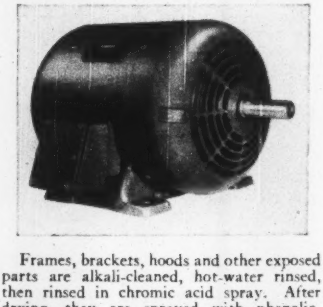
Rubber-covered, clamping arms are readily adjustable in three positions for handling loads of varying diameters.

The standard rotating clamp device is detachable. It can be installed on a standard upright or Hi-Lo Stack.

Bulletin may be obtained by request to Clark Equipment Co., Industrial Truck Division, Battle Creek, Michigan.

New Life-Line Chemical Motors

New type CSP Life-Line motors especially designed for applications where corrosive fumes and liquids are encountered, are available from Westinghouse Electric Corp.



Frames, brackets, hoods and other exposed parts are alkali-cleaned, hot-water rinsed, then rinsed in chromic acid spray. After drying, they are sprayed with phenolic-alkyd-type enamel and baked. Additional protection is provided by a coat of gray enamel and two to four baked dips of thermoset varnish, followed by a final coat of gray lacquer.

Stuart's
ThredKuT

TOPS IN PERFORMANCE!
COSTS LESS TO USE!
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D. A. STUART'S THREDKUT straight, or in rich blend, provides fine finish on tough, stringy materials because its high sulphur content gives it excellent anti-weld characteristics.

In long dilutions THREDKUT delivers long tool life and outstanding performance at low cost on free cutting, high speed operations.

THREDKUT'S exceptionally broad range of usefulness makes it cost less than "cheaper" products in the majority of cases and often eliminates the need for several different types of oils. When it comes to *performance* on the jobs within its range, *none can best it!* Write for details and literature.

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Cutting Jobs Can Be
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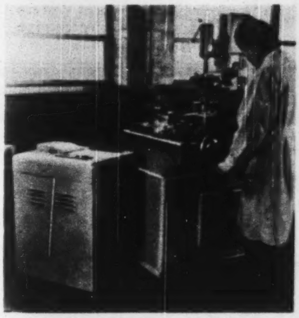
These motors use bronze split-hub, clamp-type blowers for corrosion resistance. Rotating neoprene slingers on the shafts between rear brackets and hoods are used to prevent the entrance of dirt or liquids into the bearing housings. Stator windings are double-dipped and baked in thermoset varnish. All hardware is dipped in slushing compound prior to assembly. The gasketed conduit box can be rotated to meet installation requirements.

Factory-sealed prelubricated bearings are used. No lubrication is needed for the life of the bearings.

For further information, write Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Improved Automatic Checking Recorder Announced by Michigan Tool Co.

An improved automatic checking recorder—Model MTR-1—for obtaining permanent chart records of involute tooth forms, tooth spacing, leads, contours, thread forms, etc., has been announced by Michigan Tool Co. of Detroit. Designed primarily as an accessory to Michigan Sine-Line gear checking equipment, the recorder has many other useful applications. Up to 0.002" of error, both plus and minus, can be recorded automatically across the chart of this instrument.



Outstanding among the improvements are a selective two-speed chart drive and a new standardized interchangeable precision electronic gage head. The head mounts in tandem with the indicator on a checker. Either one head can be used and transferred from one checker to another or all checkers may be equipped with identical gage heads for plugging into the recorder as desired.

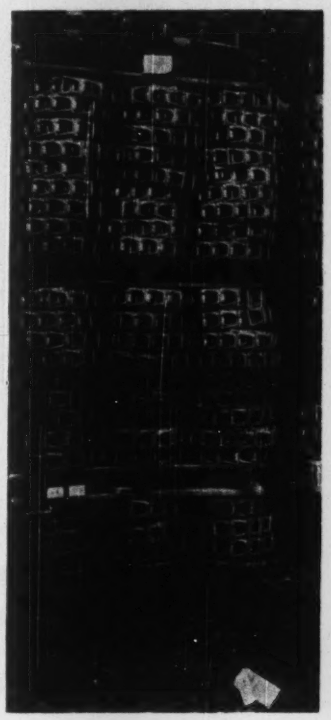
Accuracy of the new checking recorder has been improved by the all-electric 2-speed drive and improved pen mechanism. Pen movement is $^1/_8$" per 0.0001" of checker indicator finger movement. Chart drives give $^1/_2$" of travel for either 2° or 1° of work rotation. The electronic amplifier is designed to take care of normal voltage changes so that such fluctuations do not affect the instrument's accuracy.

Setting up the instrument when switching from one type of checking operation to another is extremely simple with the new design. No recorder adjustments are required when plugging in the lead from an electronic gage head mounted on a different checker. The simplified controls also help reduce the setup time to a minimum and cut down chances of error by the operator.

Other new features of the new Model MTR-1 include a convenient compartment in the base of the recorder for storing spare rolls, inks, ink pad, etc.; a specially designed

Continued on Page 44

CHAINS



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NEED CHAINS? We can ship immediately—popular types and sizes—from a large stock here in Columbus or you can contact any one of our authorized Stock-carrying Distributors, strategically located in important Industrial Centers. Our recently-enlarged Chain-making plant is fully equipped with new high-speed tools . . every modern facility to make chains scientifically better—faster.

AT ONCE

Also available is a large assortment of Sprockets, Gears, Pulleys, Babbitted Bearings and other Transmission items as well as Belt Idlers, Spiral Flights, Elevator Buckets, etc. We will be glad to take care of your requirements . . can handle those 'Ship at Once' requests promptly. May we hear from you.

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COMPRESSOR VALVE
OFFERS YOU ALL OF THESE
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1 **LARGER GAS PASSAGE AREA**
From 20% to 100% increased valve area handles more and colder gas; a colder therefore denser gas costs less to compress.

2 **LARGER VALVE AREA**
Raises back and lowers head pressure, consequently reduces compression ratio—saving more power.

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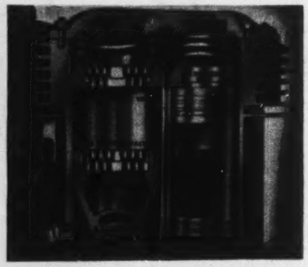
Smooth running—with less power—at higher speeds without overheating.

4 **SAFE**
No castings used—therefore no invisible blow-holes or cracks which insures safety of operation. Gas passages drilled, slotted and milled smooth—hence less friction.

5 **LONG LIFE**
Made to the highest standard of workmanship — on special machines — by craftsmen — in a modern and well equipped shop—designed to give long life under the severest conditions.

LET US SHOW YOU WHAT VOSS VALVES CAN DO FOR YOU
We will be glad to submit estimates if you will send us the name, bore, stroke and speed of your air, gas, or ammonia compressors of any type or size.



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LONG LIFE
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VOSS VALVES are indispensable for use where loads are heaviest—where safety and reliability are paramount. They run smoothly—with less power—at higher speeds — without overheating. You can replace your present valves with VOSS VALVES without any change in your compressor.

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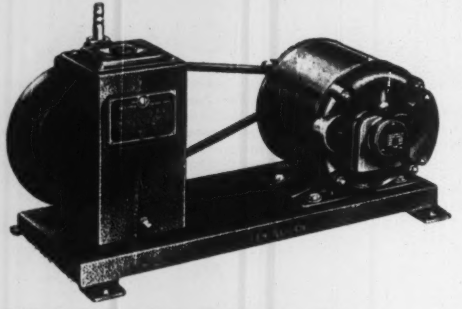

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Cenco Hyvac Pumps. These give a consistently high vacuum of 0.3 micron or better with ability to perform continuously under heavy production conditions. These sturdy qualities are uniform in each and every pump. Laboratory men prefer the Hyvac for its small size, fast action, ready portability and years of service obtained with freedom from adjustments or repairs.

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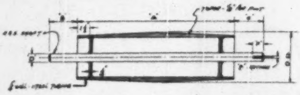
hand stamp for indicating what filing data should be filled in on each completed chart; and the use of a glossy-white interior finish which insures adequate lighting of all interior parts in case it should become necessary to service the recorder. A graduated handwheel is provided for manual operation when automatic operation is not desired.

The recorder is of rugged construction yet is completely portable, being mounted on rubber wheels for added protection when rolling it from one location to another.

Crown Faced Solid Steel Pulleys

Island Equipment Corp. 27-01 Bridge Plaza North, Long Island City 1, N. Y., announces the availability of precision machined, crown faced solid steel pulleys, complete with shafts, at new low prices.

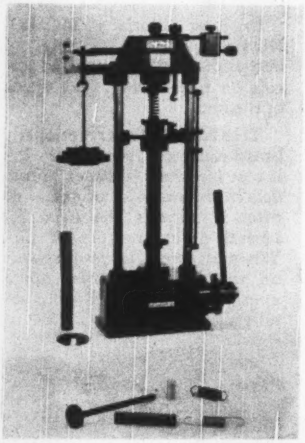


A newly developed technique enables them to produce and stock standardized solid steel precision machine pulleys from $1/4''$ wall steel tubing. This new pulley supercedes the old type welded steel pulley, which because of its lighter gauge, was subject to easy denting and bending at the edges. The new pulley also reduces belt training to a minimum.

Write now on company letterhead for complete information, prices and discounts.

Spring Testing Machines

Two newly redesigned machines for testing the loads and deflections of compression and extension springs have been made available by The Carlson Co., 277 Broadway, New York 7, N. Y.



Both machines can be used for general purpose testing and for large quantity production testing. The speed of operation, depending upon the type of test, is up to 800 spring tests per hour. Compression and extension springs may be tested at a specified loaded length, to a definite amount of deflection, or under an exact load.

These highly accurate machines are essentially precision beam balances of the simple lever type using a fulcrum, knife edges, and dead weights (no springs). The vertical shafts slide in ball bushings to eliminate tilting or jamming. Automatic stops can be set for rapid production testing, and a centering rod to reduce buckling in long compression springs is supplied.

The capacity of Type R80 is from $^{1}/_{2}$ ounce to 175 pounds, and that of Type RS-5 is from $^{1}/_{64}$ ounce to $12^{1}/_{2}$ pounds. Both testers can accommodate springs 12 inches long under test.

Descriptive bulletins and price lists are available. Sample machines for inspection are on display in the New York office of The Carlson Co.

Hydrogen-Cooled Synchronous Condenser

Destined for the U. S. Department of Interior, Bonneville Power Administration, at Snohomish, Washington, is this assembled 355,000-pound Allis-Chalmers hydrogen-cooled synchronous condenser rated 42,000/-17,500-kva, 13,800-volts, 720-rpm with a 180-kw, 250-volt enclosed exciter.

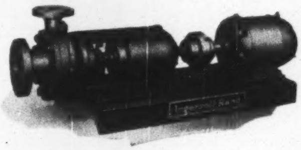
The unit's exciter housing includes coolers and condenser collector rings. It can be sealed off from the rest of the condenser at standstill for inspection of commutator and collector assembly without loss of hydrogen from the condenser chamber.

Bearings in the condenser are ring oiled and water cooled with provision for high pressure oil starting. The bearing housings include overhead rails for block and tackle removal of bearing caps and bushings.

The unit will use Regulex excitation and control equipment. The end plates shown in the photo are special shipping end plates instead of regular covers.

Cradle Mounted Centrifugal Pumps

Ingersoll-Rand announces the publication of a new four-page flier describing its new line of cradle-mounted centrifugal pumps. The bulletin shows a sectional view of the pump with all of its salient features pointed out and described. In addition the various types of drives are illustrated.



The pump itself incorporates all of the well-known and job-proven features of the Ingersoll-Rand Motorpump. Some of these

Continued on Page 46

ACTUALLY DOES MUCH MORE WORK
CLARK

The UTILITRUC 10,000-lb FORK-LIFT TRUCK

Clark's NEW

Heavyweight **CHAMPION** *with* DYNA TORK Drive

Clark announces the Utilitruc-100—a 10,000-pound-capacity gasoline-powered fork-lift truck added to its steadily-growing line of materials-handling machines and attachments.

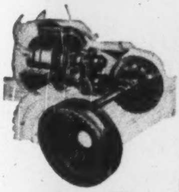
INCREASED WORK CAPACITY **. . . In a neutral competitive test, this versatile giant performed 20 per cent more work than conventional-drive machines of equal capacity . . . mainly because of its Dynatork Drive, which utilizes power more efficiently and eliminates waste motion. The Dynatork Drive transmits engine power to the wheels through a magnetic field, across an air gap—no friction clutch, no conventional transmission.**

EASY TO HANDLE **. . . Compactness, short turning radius, easy steering and absolutely smooth travel contribute to its unequalled efficiency, and virtually eliminate driver fatigue.**

REDUCED MAINTENANCE **. . . Elimination of many working parts including major points of wear has cut sharply the time and cost of maintenance and service.**

WHERE TO USE IT **. . . In steel mills and warehouses; in other metals-handling operations; in body-building plants, building supply yards and other installations where loads are heavy and difficult to handle. Usefulness to the stevedoring industry also is indicated.**

WHAT TO DO ABOUT IT **. . . Full information about Utilitruc-100 is worth getting and easy to get—simply use the coupon. Clark's Material Handling News, and its stimulating movies also are available upon request.**



DYNA TORK Drive

CLARK ELECTRIC AND GAS POWERED FORK TRUCKS AND INDUSTRIAL TOWING TRACTORS

INDUSTRIAL TRUCK DIVISION • CLARK EQUIPMENT COMPANY • BATTLE CREEK 83, MICH.

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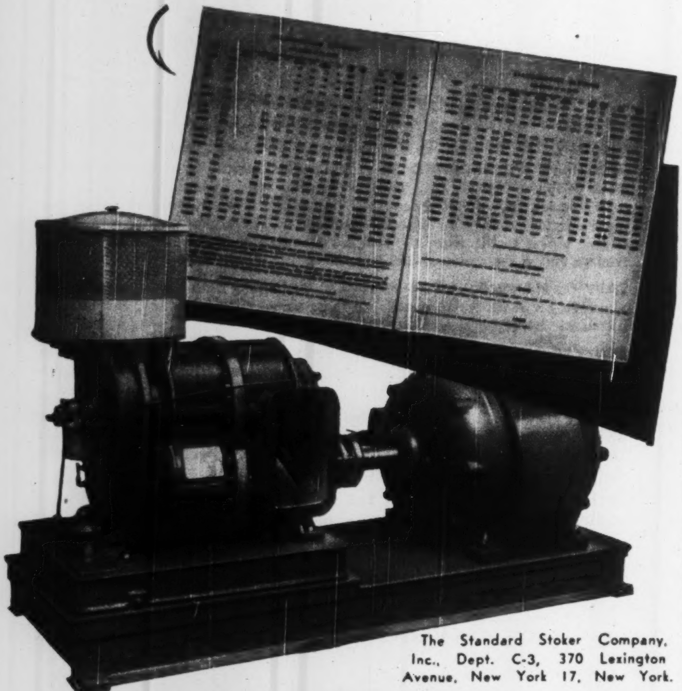
The STANDARDAIRE
PRECISION BUILT
Axial Flow BLOWER

To meet specific and variable pressures, Standardaire Positive Displacement Blowers are built in a series of sizes to fulfill a wide range of capacity requirements from directly connected, standard speed motors—the modern method of producing just the amount of air required at the minimum cost. Direct-drive motor speeds also provide for an even air flow resulting in smaller pulsations that are easy to dampen out and do not create shock loads in the blower or delivery system. If the type of service demands other than direct drive, a pulley attachment can be readily applied to the blower for particular specifications.

The flexibility of speed and pressure possible with the Standardaire Blower eliminates a great number of blower types normally required in the positive displacement field—a desirable engineering advancement in blower design without disturbing fundamental principles.

For full information and a complete list of blower sizes, write for Standardaire Selection Chart, Publication No. 86.



The Standard Stoker Company, Inc., Dept. C-3, 370 Lexington Avenue, New York 17, New York.

THE STANDARD STOKER CO • INC •

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are deep water-cooled stuffing box, smothering gland, ring oil lubricated ball bearings, a heavy cradle shaft and bearing, sturdy channel steel baseplate and an all metal coupling.

The impeller is of the latest hydraulic design, mechanically and hydraulically balanced. An extra deep stuffing box accommodates 5 or more packing rings and due to the side-opening cradle, it is easily accessible.

The pumps are built in 5 different sizes, single and two stage. Sizes range from $^3/_4$ inch to 5 inches discharge with capacities up to 1600 gpm and heads up to 250 feet. Normal horsepower range is from $^1/_4$ to 75.

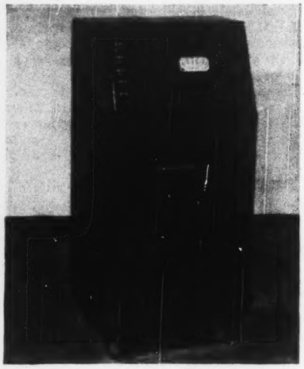
The pumps may be driven by direct electric motor, electric motor and V-belt, turbine through reduction gears, direct turbine, V-belt gasoline engine or direct gasoline engine.

Due to the flexibility and ease of changing drivers, the pumps are suitable for paper mills, breweries and distilleries, chemical plants, refineries, building and contracting and general manufacturing process.

For additional information contact Ingersoll-Rand Co., 11 Broadway New York 4, N. Y. or any of its numerous branch offices.

Insulation Tester Available from Westinghouse

An insulation tester to assist in the development and control of insulating coatings for copper wire, and other applications involving dielectric stress studies, is available from the Westinghouse Electric Corp. The tester consists primarily of a high-voltage transformer, a motor-driven auto-transformer, an indicating voltmeter, and mercury cups or terminals for connecting the specimens.



Two models are available; one rated at 35 kv, 5 kva; the other at 12 kv, 0.5 kva. Cabinet dimensions are 20 × 16 × 35 inches. Overall weight is approximately 300 pounds.

Control of the accelerating secondary voltage is automatic. A constant speed motor drives an auto-transformer which energizes the primary of the high-voltage transformer. The standard rate of rise of the secondary voltage is 500 volts per second. At breakdown of the specimen insulation, an overcurrent relay operates to stop the motor driving mechanism and to open the primary, deenergizing the circuit. The rectox-type voltmeter has a linear scale and will remain fixed at the breakdown voltage until the motor drive mechanism is reset to zero.

An auxiliary feature of the instrument is that it can be used for fatigue testing. Automatic operation is assured by the use of a

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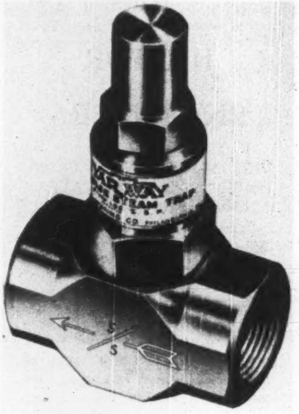
timer that records actual test time that the specimen is under stress.

For further information, write the Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

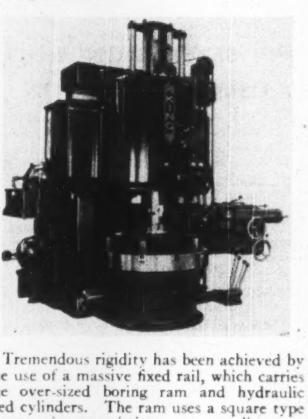
Steam Trap Has New S/S Body



To provide additional resistance to the abrasive wear and corrosion encountered in severe steam trapping service, the "Yarway" Impulse Steam Trap is now made with body of Type 416 stainless steel bar stock. Internal parts, as before, are made of selected stainless alloys. Product of Yarnall-Waring Co., 108 Mermaid Ave., Philadelphia 18, Pa.; described in company Bulletin T-1739, available on request.

New Type Diesel Wheel Boring Machine

The King Machine Tool Div. of American Steel Foundries, manufacturers of the well-known line of "King" Vertical Boring and Turning Machines, announces the development of a Special Diesel Wheel Boring and Facing Machine.

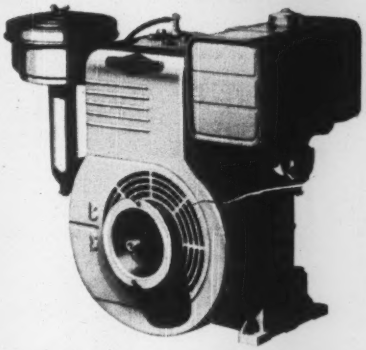


Tremendous rigidity has been achieved by the use of a massive fixed rail, which carries the over-sized boring ram and hydraulic feed cylinders. The ram uses a square type construction permitting accurate alignment and easy adjustment by four large gibs. The cycle of this ram is fully automatic and can be set to rapid traverse to the work, rough bore at one feed, finish bore at another feed,

Continued on Page 48

Compact...

and TOUGH



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Briggs & Stratton 4-cycle, single-cylinder, air-cooled gasoline engines are produced by an organization with over 30 years of engineering and manufacturing experience gained during the building of more than 4½ million air-cooled engines.

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This attractive 16-page Bulletin gives you the "behind-the-scenes" view of DOWNINGTOWN. It contains data about general facilities, manufacturing equipment, welding procedure qualifications, and standard Heat Exchanger construction details.

The Bulletin also has sections devoted to typical Plate Fabrication and Heat Exchanger examples, with story and illustrations of the plant and of manufacturing procedures. In the section of this Bulletin devoted to Heat Exchangers, certain details of construction which we deem important are outlined.

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form a radius at another feed, then dwell and rapid traverse out of the work.

A special motor operated power chuck holds the wheel securely and speeds up the loading and unloading operations.

The separate hydraulic power unit for actuating this boring head is located on the side of the machine. An over-sized side head assembly permits full use of the carbide tooling even while extended to machine the hub details.

One of the world's largest manufacturers of diesel locomotives has recently increased wheel production fifty per cent due to the outstanding design of this equipment.

Complete engineering details and cycle description are available. Address American Steel Foundries, King Machine Tool Div., Cincinnati 29, Ohio.

New Constant-Voltage Megger Insulation Tester

This low-cost insulation resistance tester has all the advantages of the Midget "Megger" Tester, plus a new improved generator, flush terminals and durable, modern-design plastic case. In addition, it is available with ohm scale and selector switch in ranges 0 to 10 megohms (100 volts) 0 to 20 megohms (250 volts) and 0 to 50 megohms (500 volts).

For average requirements, such as encountered in industrial plants, by electrical contractors and for inspection work, this new constant-voltage set should prove ideal. Its most important uses include the diagnosis of trouble in all types of electrical equipment, including motors, generators, rotary converters, transformers, excitors, power cables and wiring, lighting circuits, control equipment and wiring switchboards, appliances, electronic and communication equipment, radio and radar equipment, meters and relays, industrial heating units and furnaces, railway signaling, train control, car lighting and air conditioning, fire alarms, police telegraph and traffic signaling equipment, airplane and airport wiring and equipment.

Insulation resistance of electrical equipment is seldom, if ever, free from capacitance and dielectric effects, therefore the constant-voltage feature of this instrument becomes highly important as a source of steady d-c test voltage. The slip clutch or centrifugal governor built into the driving mechanism permits cranking at varying speeds without effect on the voltage output of the instrument.

For information on this useful new instrument write for Bulletin 21-80-50 to James G. Biddle Co., 1316 Arch St., Philadelphia, Pa.

PROFESSIONAL GUIDE for JUNIOR ENGINEERS

THIS 56-PAGE PUBLICATION, ISSUED BY THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT, WAS WRITTEN BY THE LATE DR. WILLIAM E. WICKENDEN, AND EDITED BY G. ROSS HENNINGER

The book seeks to give the young engineering graduate a sense of professional values in chapters on engineering origins and professional relationships. Full treatment is given to the practical side of getting an engineering job and of advancing in the profession. Also included is the Council's credo "Faith of the Engineer," a self-appraisal questionnaire, and the Canon of Ethics for Engineers.

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New Consolidated Telereader-Telecorder System Speeds Evaluation of Chart Data

Consolidated Engineering Corp., 620 N. Lake Ave., Pasadena 4, Calif., announces the "Telereader," an instrument for the rapid reading of data points from oscillographic (or similar) charts up to 12 inches wide—and when used with a companion instrument, the "Telecorder," for the recording of up to 50 data points per minute on IBM cards.

Such rapid reading and recording of chart data is extremely useful in evaluation of multitrace oscillograph records containing many categories of information recorded simultaneously. In a matter of hours an oscillograph, for example, is capable of recording data which may require hundreds of man-hours for evaluation by older methods. With the "Telereader-Telecorder" combination, chart evaluation often can be accomplished in minutes. Operator fatigue is virtually eliminated and accuracy far exceeds that of manual reading.

The "Telereader" provides digital coordinate readings of any selected data point on the chart (with respect to reference axes). Through the "Telecorder," these digital coordinates (together with other necessary data such as coding symbol, correction and calibration factors, etc.) are recorded by an IBM Summary Punch Unit on IBM cards. The IBM cards so obtained then can be processed through a wide choice of automatic sorting and computing operations on IBM machines. Thus in a few minutes, many categories of information are made available which formerly could have required hours of laborious calculation.

Operation of the "Telereader-Telecorder" combination is simple. The chart is run through an optical system in the "Telereader," which projects the contents of the chart, enlarged $2^1/_2$ diameters, upon a 15" × 30" ground-glass viewing screen. (Actually, two optical systems are provided: A reflecting system for opaque paper charts and a transmission system for film charts.)

A system of two crosswires is incorporated in the optical system and its image appears on the viewing screen, free from distortion, superimposed on the contents of the chart. Each crosswire can be positioned independently by means of a conveniently located handwheel. Wherever positioned, crosswires remain at right angles to each other.

To read a data point on a chart, the operator moves the crosswires so as to place their intersection on the data point being read. (Zero backlash in the gear system activating the crosswires permits approach to the data point from either direction with equal accuracy.) Two digital counters mounted on the left side of the "Telereader" give a continuous indication of the crosswire positions

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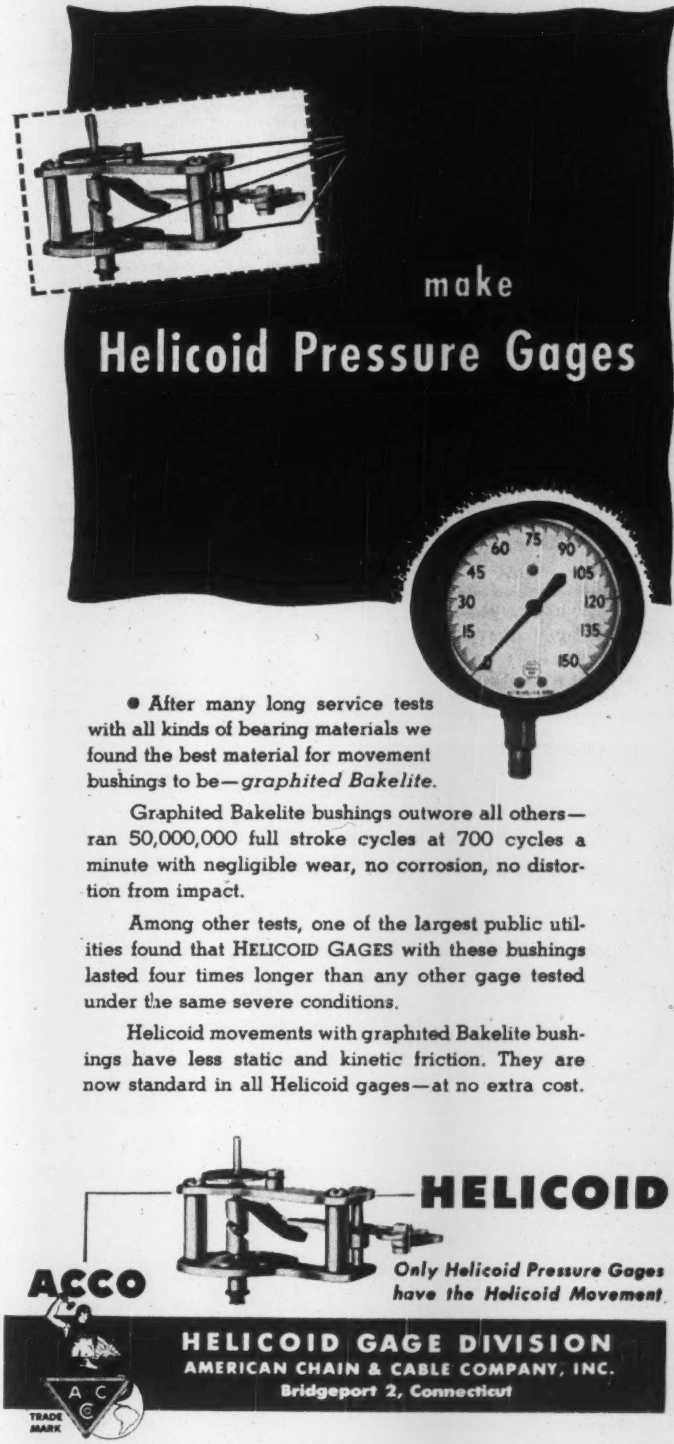

make

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● After many long service tests with all kinds of bearing materials we found the best material for movement bushings to be—*graphited Bakelite.*

Graphited Bakelite bushings outwore all others—ran 50,000,000 full stroke cycles at 700 cycles a minute with negligible wear, no corrosion, no distortion from impact.

Among other tests, one of the largest public utilities found that HELICOID GAGES with these bushings lasted four times longer than any other gage tested under the same severe conditions.

Helicoid movements with graphited Bakelite bushings have less static and kinetic friction. They are now standard in all Helicoid gages—at no extra cost.

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Watch Your Step!

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IRVING "VIZABLEDG" TREADS

With The Distinct Nosing

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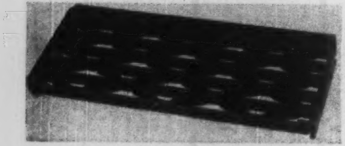
RIGID



Riveted type with grating nosing.

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HALLOWELL Solid Steel Collars, functionally proportioned throughout . . . precision-machined so faces run perfectly true . . . are beautifully polished all over . . . yet they cost less than common cast iron collars. 3" bore and smaller are made from Solid Bar Stock. To make sure the collar won't shift on the shaft, they are fitted with the famous UNBRAKO Knurled Point Self-Locking Socket Set Screw—the set screw that won't shake loose when once tightened. HALLOWELL . . . a "buy word" in shaft collars . . . available in a full range of sizes for IMMEDIATE DELIVERY.

Write for name and address of your nearest HALLOWELL and UNBRAKO Industrial Distributors.

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with respect to their reference trace or zero point. A handwheel permits operator to keep the reference-trace follower on the reference trace at all times.

Chart speed is controlled through a foot pedal. (Chart speeds are from $^1/_2$ to 1200 inches per minute, forward; 12 to 120 feet per minute, reverse.) Operator may periodically move chart forward in sections and take a number of readings in each position; or he may move the chart continuously at a slow rate, keeping the crosswires on a given trace. In either case, he presses a button to record coordinates of a given data point on an IBM card.

When the button is pressed, the coordinate quantities, in the form of binary numbers standing in the "Telecorder," are recorded to the nearest thousandth inch. Since the electronic counters will add, subtract, and read out while crosswires are in motion, high-speed continuous recording is possible—up to the punching limit of the IBM Summary Punch Unit, which is 50 data points per minute.

The actual speed of operation and the accuracy of reading data points, depend, to a great extent, upon the care and proficiency of the operator in positioning the crosswires on the data points sought. (Crosswires can be moved 12 inches in 3 seconds.) A reasonably skilled operator can record as many as 40 data points per minute, under favorable conditions, from an oscillograph chart. Readings from good sharp records, as a rule, can be duplicated within ±0.05" in routine operation.

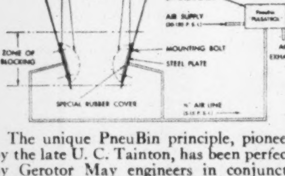
The "Telereader" may be operated by itself when the speed afforded by manual reading and copying of digital data is considered adequate, or where, for any reason, card punching is not desired. Operator proceeds in same manner, except instead of pressing a button to record data-point coordinates, he reads coordinates directly on visual counters.

The "Telereader" is available with a single crosswire (Type 25-105C1) or with double crosswires (Type 25-105C2), with corresponding "Telecorders." Both "Telereader and Telecorder" are housed in sheet-metal cabinets with handsome grey-crackle finish. "Telereader" (double-crosswire) measures 36" wide, 37$^1/_2$" deep, 55$^1/_4$" high. "Telecorder" (double-crosswire) is 24" wide, 16" deep, 36" high.

For further information, write for CEC Bulletin 1518.

Bin Feed Problem Solved by PneuBin

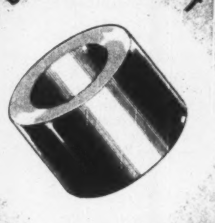
Baltimore, Md.,—A new solution to the problem of feeding stubborn materials through bins and hoppers is provided by the PneuBin, a pneumatic device now manufactured by the Gerotor May Corp.



The unique PneuBin principle, pioneered by the late U. C. Tainton, has been perfected by Gerotor May engineers in conjunction with technical men of the B. F. Goodrich and Tainton companies.

Pulsating PneuBin panels, strategically mounted on the inside walls of bins or hop-

WORKS WHERE OTHERS WON'T



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pers, keep materials moving by positive displacement, thus preventing arching, funneling and tunneling. Flexible covers for the panels are made of reinforced, highly abrasion-resistant Goodrich Armorite rubber. Air flow to and from the panels is automatically regulated by the PneuBin "Pulsatrol" unit, permitting selection of a wide range of pulsation frequency, force and amplitude.

Special advantages of the PneuBin include direct action on bin contents rather than the bin, positive extrusions, easy installation, quiet vibrationless operation, maximum safety and economy. Use of the PneuBin permits closed bin tops and bin storage of materials previously considered impossible to feed from bins.

Applicable to all types of bins and hoppers, the PneuBin assures a dependable flow of even the most difficult industrial materials, such as foods, chemicals, minerals, soap products, pigments and dyes.

Complete information on the PneuBin can be obtained from the Gerotor May Corp., Dept. E, Baltimore 3, Maryland.

Strain Indicator

A new Type "L" portable, battery-powered strain indicator, for use with SR-4 R bonded resistance wire strain gages, is announced by The Baldwin Locomotive Works, Philadelphia 42, Pa. The new instrument is a refinement of Baldwin's Type "K" instrument with several important new features.

Four major improvements have been made in this direct reading instrument. First, the ten "Thousands" steps are increased from 1000 to 2000 microinches per inch per step, giving a total of 20,000 microinches per inch. This improves the convenience of the instrument and minimizes the use of the Range Extender switch. Accuracy is unaffected because the scale on the balance indicator dial is unchanged.

Second, the Range Extender has been increased from an approximate 10,000 microinches to a more exact 20,000 microinches with an accuracy within plus or minus 50 microinches. This change extends the balancing range of the instrument to plus or minus 30,000 microinches, which is broad enough to cover all practical applications of SR-4 strain gages. The broader range of this instrument permits measurements in the plastic range of metals and balancing the bridge when dummy gages are unusually far off balance.

Continued on Page 52

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WHEN YOU WANT TO PUT A CONTROL IN A HANDY POSITION

This instrument (shown in part with cover removed) is an excellent example of how a short length of S.S.White flexible shafting can be used to control an inaccessible part from a convenient outside point.

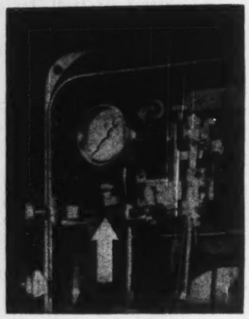

Photo courtesy of C. J. Tagliabue Mfg. Co., Bklyn, N.Y.

This is just one of hundreds of design problems that have been solved in a simple, low-cost way with S.S.White remote control and power drive flexible shafts. It will pay every designer to be familiar with these versatile, adaptable mechanical elements. For information,

GET THESE FLEXIBLE SHAFT FACTS

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BULLETIN 4501 has details on how to select and apply flexible shafting. Write for a free copy.

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Third, the new model can be used with a completely external Wheatstone bridge circuit without modifying the internal circuit. This can be done by changing connections X and Y on the instrument binding posts.

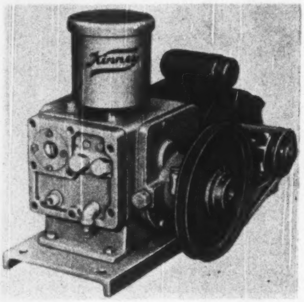
The fourth change is provision of an oscilloscope connector jack for applications in rephasing problems sometimes encountered when using extremely long leads (50 to 100 feet) between SR-4 strain gages and the instrument. This connector can also be used for limited dynamic studies because the jack is connected into the amplifier section of the instrument and will permit pre-amplification of the strain gage signal so that it can be read on a standard oscilloscope.

Measuring accuracy has been improved also. The "Thousands" steps have a tolerance of plus or minus $2\frac{1}{2}$ microinches per inch. Slide wire tolerance is plus or minus 5 microinches per inch and the Gage Factor adjustment is accurate to plus or minus $\frac{1}{4}\%$ at any point.

The instrument is designed and calibrated for 120-ohm gages with gage factors of 1.77 to 2.20. However, gages of other resistances and gage factors may be used if necessary. An AC-DC converter is available for operating the indicator on 110-volt, 60-cycle, single-phase electric power when required for continual operation. The instrument dimensions are 6 × 9 × 12 inches and it weighs about 25 lb. with batteries.

Kinney Announces New Vacuum Pump

Kinney Manufacturing Co., 3582 Washington St., Boston, Mass., manufacturer of high vacuum pumps, liquid pumps, and bituminous distributors, has brought out a new small, compound vacuum pump, Model CVD 3534. This pump employs the unique oil-seal pumping system that has made Kinney Vacuum Pumps so satisfactory where high vacuum and consistent pumping speeds are necessary.



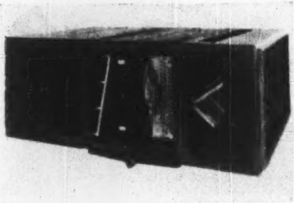
Model CVD 3534 has a free air displacement of 4.9 cu. ft. per min. (139 liters per minute) and operates with a $\frac{1}{3}$ HP motor. On a blank test, each unit is required to produce McLeod gauge absolute pressure readings of 0.1 micron (0.001 mm Hg.) or better. This Model is extremely compact... less than 16" in height. It is ruggedly built, quiet in operation, and easy to service. Double sealing-oil reservoirs provide continuous oil purification which promotes the consistent production of high vacuum regardless of surrounding atmospheric conditions.

The new pump requires no "warm-up" period—an important feature of Model CVD 3534. It's ready to go to work at all times—at the snap of the motor switch. For complete information, address the manufacturer.

• Keep Informed

Westinghouse Announces New Air Handling Units

A new line of air handling units, designated Types AH and AV, intended primarily for remote installation in central plant type air conditioning systems is available from Westinghouse Electric Corp. These units can also be used for commercial and industrial heating and ventilating. Sizes range from 1,650 to 14,060 cfm at 500 fpm coil face velocity when direct expansion coils are used and up to 18,000 cfm when water coils are used. Standard and double tube steam heating coils are also available. All coils utilize continuous plate fin construction.



Of standardized design and construction, each unit consists of a fan section—with two backwardly inclined blade Silentvane type fan wheels mounted on a common shaft—and a coil section with drain pan for cooling and heating coils, depending upon the requirements. Filter sections, face and by-pass dampers, and other accessories are available.

The fan section is composed of a fabricated steel angle frame enclosing the double fan unit with its shaft and bearings, and supporting the motor and drive. This unique design minimizes space requirements. Design is such that the motor and drive can be mounted at either end and the exhaust outlet positioned for horizontal or vertical discharge. The two fans discharge through a common outlet flanged for connection to duct-work.

The coil section consists of an angle iron frame with insulated panels. It accomodates the standard Westinghouse-Sturtevant heating and cooling coils and the optional face and by-pass dampers. Cooling and dehumidifying are provided for the summer; heating and humidifying for winter.

For further information write Sturtevant Division, Westinghouse Electric Corp., Hyde Park, Boston 36, Mass.

New Radiography Technique Speeds Ship Sailing

When steam boilers or pressure carrying steam piping aboard a ship are repaired, replaced or modified by welding, it is necessary to satisfy the responsible and governing inspectors as to the satisfactory nature of the welds made. They must be free of cracks, excessive holes or slag inclusions and must represent good fusion of the base metal. The customary method of inspection is that of gamma ray or Radium radiography.

Gamma ray radiography required a suitable source of the rays, such as Radium or other radioactive material methods for suspending this source in a proper position on one side but at some distance from the weld; suitable film in special cassettes with special intensifying screens; methods of holding these cassettes in position on the other side but close to the weld; suitable penetrameters to prove the sensitivity of the procedure; a calculated time for the exposure;

Continued on Page 54

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suitable dark room facilities for loading and unloading cassettes and developing the film; and considerable know-how and experience.

The entire procedure may take considerable time. An example was in a recent ship case where certain nozzle additions were made to the current boilers. Radium radiography of the welds by conventional methods required for each nozzle several hours for set up time, some 14 hours of radium exposure and in addition several hours for processing of the film away from the ship.

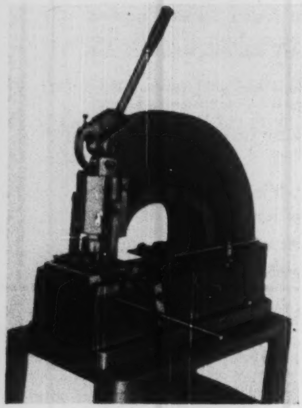
Similar nozzle additions were required to be made to another ship. The ship was ready to sail, passengers awaiting embarkation were being housed at local hotels at the ship's expense, the crew was being paid, pier and other charges were mounting, every hour of delay meant many dollars. Sam Tour & Co., Inc., New York City, field personnel applying their new radiographic technique and field equipment, reduced the time required for each nozzle for setting up to less than an hour and the radium exposure time to $2^1/_2$ hours. By taking portable dark room film developing equipment aboard the ship, the films were developed and viewed by the inspectors within 15 minutes after exposures were finished. The net result was the saving of several days of total time and a like advance of the sailing date of the ship.

The new techniques involved the making of a scale drawing to enable exact exposure calculations, the simultaneous use of two or more gamma ray sources, the use of heavy lead shields to stop cross radiation plus the use of portable dark room equipment.

The New "Di-Acro" Punch No. 2

O'Neil-Irwin Mfg. Co., 308 Eighth Ave., Lake City, Minn. announces the new "Di-Acro" Punch No. 2 has been designed to provide greater throat depth than has been heretofore available in the "Di-Acro" Punch line. Its 12" throat allows working to the center of a 24" wide sheet.

In addition to its ability to perforate holes of various shapes and sizes as large as 4" in diameter, it can also be employed as a precision punch press for an unlimited variety of blanking, drawing, embossing and forming operations.



The powerful action of this precision machine is obtained through a roller bearing cam of exclusive "Di-Acro" design which converts a small amount of operator effort into a tremendous pressure at the point of impact.

An unusual feature of the "Di-Acro" Punch No. 2 is its triangular shaped ram which is hardened and precision ground for extreme accuracy. Since turning or twisting of this triangular ram is impossible, the position of the punch head is positively controlled assuring perfect alignment at all times.

The flexible gauging arrangement built into the "Di-Acro" Punch No. 2 can be quickly and accurately adjusted to provide precision location of the material for exacting operations. A wide variety of readily interchangeable punches in round, square, oval and rectangular shapes are available for this precision machine thereby making it ideal for both experimental work and production operations.

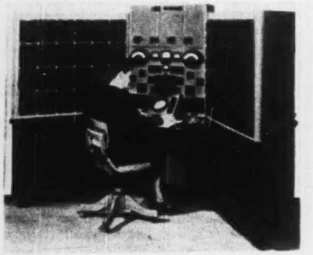
Although the "Di-Acro" Punch No. 2 has been primarily designed for short run operations, it is often practical for production quantities in light weight materials where a hand-operated machine can be employed more effectively than a power unit.

The new "Di-Acro" Punch No. 2 is an extremely valuable addition to the "Di-Acro" line of Precision Machines as it will perform either primary or secondary operations on parts being processed through the "Di-Acro" System of Die-Less Duplicating.

Principal Strain Computer

A new electronic computing instrument for automatically computing and indicating principal strains was developed and built by the Hathaway Instrument Co. for the National Advisory Committee for Aeronautics, and it is now in operation at Langley Field, Va.

This computer operates directly from strain gage rosettes, indicating almost instantaneously the values of major principal strain, minor principal strain, and the principal angle.



Principal strains are determined experimentally by means of the strain gage rosette which is an arrangement of 3 or 4 resistance strain gages mounted on the surface under test at definite angles with each other. The voltage outputs of each gage are translated into strain, and then these individual strain values are placed into equations or formulas which yield the desired values of principal strains and the principal angle. Equations differ for different arrangements of gages in the rosette, but all equations involve sums and differences and square roots of sums and/or differences squared.

The principal strain computer operates with equiangular rosettes, rectangular rosettes, and with T△ rosettes. To convert from one equation to another, it is merely necessary to operate a single selector switch.

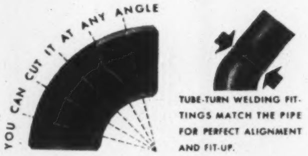
The sum and difference factors are obtained by networks, operating directly on the outputs of the individual gages. The square root of the sum of several squares is obtained almost instantaneously by a self-balancing electrodynamometer.

The rosettes are powered by a 400-cycle carrier and all operations in the calculations

HOW TO SIMPLIFY ODD-ANGLE PIPING

The ease with which pipe can be installed at odd angles for compactness is an important reason for the widespread preference for Tube-Turn Welding Fittings.

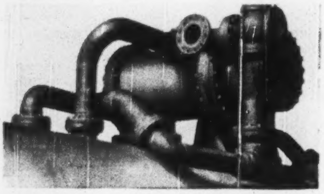
For example, one of the country's leading consulting engineers (name upon request) states: "We employ a great number of experienced welders in all parts of the country. They all prefer Tube-Turn Welding Fittings because many of the fittings we use must be cut to odd angles. When lining up the fittings, cutting them and placing them into the line, our welders say they are more


YOU CAN CUT IT AT ANY ANGLE
TUBE-TURN WELDING FITTINGS MATCH THE PIPE FOR PERFECT ALIGNMENT AND FIT-UP.

sure of accurate alignment and fit-up with Tube-Turn Welding Fittings than with any other make."

There's good sound reason behind this preference. Tube-Turn Welding Elbows and Returns are formed to give you *true circularity . . . accurate curvatures and center-to-face dimensions . . .* and *absolute uniformity of wall thickness. Hence, you can cut a Tube-Turn Welding Elbow or Return to any odd angle required and it will line up perfectly with the pipe.*

Tube-Turn Welding Fittings are available in a *complete range of sizes, shapes and materials.* For speed, simplicity and versatility in piping installations, be sure you get *genuine* Tube-Turn Welding Fittings.



Tube-Turn Welding Fittings simplify the fabrication of intricate piping system designs such as the installation shown above. Their true circularity and uniform wall thickness permit cutting and welding them at any odd angle.

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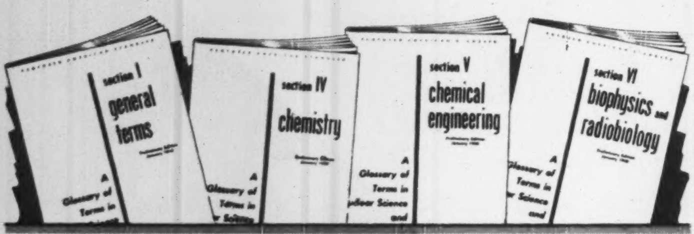
section I
general terms
A Glossary of Terms in
section IV
chemistry
A Glossary of Terms in
section V
chemical engineering
A Glossary of Terms in Nuclear Science and
section VI
biophysics and radiobiology
A Glossary of Terms in Nuclear Science and

A GLOSSARY OF TERMS
IN NUCLEAR SCIENCE AND TECHNOLOGY

This new Glossary of nuclear terms represents coordination and extension of the work started a few years ago by scientific and technical societies, trade associations, and governmental organizations. Included in the compilation are all general terms, as well as those used in the following fields:

Reactor Theory
Reactor Engineering
Chemistry
Chemical Engineering
Biophysics and Radiobiology
Instrumentation
Isotopes Separation
Metallurgy

For the convenience of users the Glossary will be published in nine sections. Each of these will include terms (together with their definitions): (1) peculiar to the field of nuclear energy, (2) used in this field in a different sense or with different emphasis from what is most commonly understood in other connections, and (3) used elsewhere in the same way but so infrequently as to be unfamiliar. An alphabetical arrangement of the terms of all sections is also included to enable the user to readily determine the section or sections in which definitions of the terms will be found.

Sections now available cover Chemical Engineering and Biophysics and Radiobiology. In the former are 120 terms and definitions while in the latter the listings total 250.

The other seven sections are now being edited by a committee of the National Research Council and will be published before the end of 1950. By ordering those of interest to you *NOW*, you will make certain of obtaining copies upon publication. For titles of sections and prices, see order form below.

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are performed on this carrier without any modulation or demodulation, and wave-form and frequency are not critical.

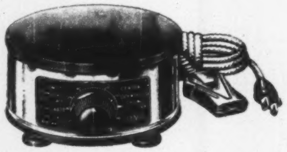
The computer contains all the oscillators, amplifiers, and power-supply equipment within one cabinet, for operation directly from a single source of 115-volt 60-cycle power. A total of 75 vacuum tubes used.

A total of 48 rosettes, either of the 3-gage or 4-gage variety may be connected to the computer and each gage properly balanced before strain determinations are made. After each increment of strain is applied, the operator can read and record the major and minor principal strains and the principal angle just as fast as he can operate the rosette selector switch and read and tabulate the results.

Built-in calibrating equipment is provided for quick and precise calibration for the rosette to the strain and angle indicators.

New Thermostatic Hot Plate

The Central Scientific Co. is introducing a new thermostatic hot plate.

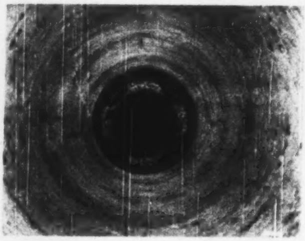


The thermostatic heat control built into this No. 16633 Hot Plate makes it a convenient device for maintaining liquids at approximate predetermined temperatures from 150° to 600° F. The heating source is a Calrod unit cast into the 6-inch diameter iron top. The body is stainless steel. This unit operates on 115 volts with a power demand of 500 watts.

This thermostatic hot plate is low in price and should prove a popular item for research laboratories.

A copy of Cenco News Chats No. 66 containing a description of this new hot plate and other interesting new items will be sent to those writing Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill.

Armco Bellefonte Blast Furnace



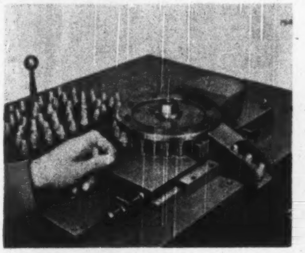
A seldom seen view of a blast furnace. Taken after the first relining of Armco Steel Corp.'s Bellefonte Furnace at Ashland, Ky., the photograph shows the hundreds of thousands of brick required to line a modern furnace. The bull's-eye is the lower charging bell, surrounded by the uptake main openings and the dark ring of the wearing plates.

Bellefonte was blown-in on August 20, 1942, and had produced 2,627,950 tons of pig iron when it was blown-out on May 14, 1949. The furnace is 100 ft. high, 27 ft. 3 in. in diameter and contains the equivalent of 738,612 nine inch bricks.

• Keep Informed

New Semi-Automatic Machine Marks Cone Shaped Parts

The new machine illustrated was developed by Acromark, Elizabeth, N. J. for marking small fuses, but is adaptable to the marking of a wide variety of parts by the simple changing of the ring feed.



A new marking principle is involved, that of a combination dial feed (ring dial) and rotary marking operation. The marking is not accomplished by forcing the parts against a concaved stationary die, but by a short dwell in contact with a rotating die as it rotates the part in the ring dial.

This is the successful and positive application of an old principle applied, to our best knowledge, for the first time to marking. It is known in the Engineering field as the Geneva Principle and is a mechanically perfect principle for this application, because it combines a repetitious dwell with continuous rotary action.

To operate, after throwing the starting switch, the lever at the left controls the speed through a speed variation unit. The parts are placed on the ring dial between freely rotating cradle rolls, bushing mounted. With a positive dwell for each marking, the loading is also accomplished during this dwell, and even at 20 parts a minute or in fact as fast as desired, the operation is smooth and positive.

As the fuse or part reaches the constantly rotating marking roll it is rotated and marked by the marking roll after which a guide carries it out on a chute.

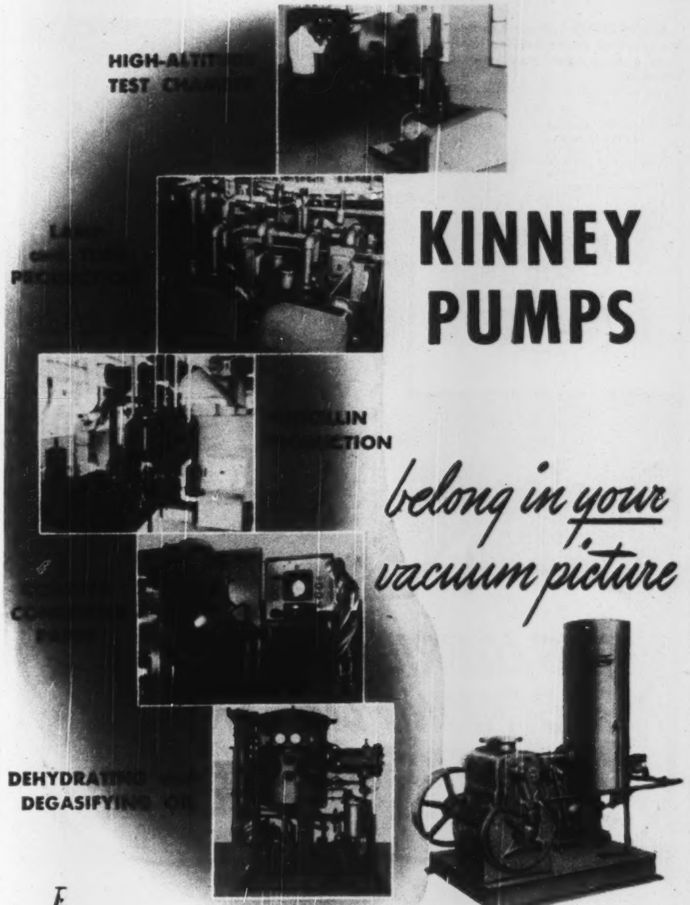
For marking depth the ring dial is mounted upon a slide plate with lock screw adjustment as indicated in the illustration. The marking roll drive being separate from the ring dial drive, this slide adjustment is practical.

An A.C. $1/2$ H.P. 60 Cycle, 1 Phase Motor is mounted inside the machine with variable speed unit. Push button switch is mounted near the variable speed lever. A removable side plate giving complete access to all moving parts is provided. This machine is designated as Acromark Model No. 53 and further details will be furnished upon application to The Acromark Co., 345 Morrell St., Elizabeth, N. J.

New Type of Diesel Engine

A completely new type of diesel engine, in the 195–375 hp range, has been announced by the Ingersoll-Rand Co. Designated as the TS diesel, this engine incorporates many new design features which have resulted in a previously unattainable combination of characteristics. According to the manufacturer, the TS diesel can easily be made portable, but is not automotive-type; it is small in size, but with big-engine design; light in weight, but with moderate speed; powerful, but with low exhaust temperature; perfectly balanced, but with no balancing devices. It is a four-cycle, 7"-bore, $8^1/_2$"-

Continued on Page 58



In thousands of successful applications of low pressure processing, *Kinney Vacuum Pumps* are setting the pace for speed and economy. Fast pump down means fast processing time — and that's why *Kinney Pumps* are so often picked for the job. In one case they are creating the low absolute pressure required in a gigantic synchro-cyclotron . . . in another, they are helping to turn out a steady stream of peanut-sized electronic tubes. Whether it's "one of a kind" or "mass production", *Kinney Pumps* have the stamina and rugged dependability to meet the toughest service conditions in every field . . . pharmaceutical or food, metallurgical or optical, electrical or electronic.

Single Stage Models are available in eight sizes: capacities from 13 to 702 cu. ft. per min. — for pressures to 10 microns Hg. abs. Compound Kinney Vacuum Pumps are furnished in three sizes — capacities 5, 15, and 46 cu. ft. per min. — for test pressures to 0.5 micron Hg. abs. Send for Bulletin V45 — the complete story on Kinney Vacuum Pumps, Oil Separators, and other Vacuum Pumping Accessories.

Kinney Manufacturing Company, 3582 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

Foreign Representatives: General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England . . . Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia . . . W. S. Thomas & Taylor Pty., Ltd., Johannesburg, Union of South Africa . . . Novelectric, Ltd., Zurich, Switzerland.

Making old things better
Making new things possible
KINNEY Vacuum Pumps

GLOBE ROTO-CUT meat cutters are the standard of the Packing Industry. They produce better meat products at higher speed.

The Ball Bearing and The Spherical Roller Bearing on the cutter shaft of the GLOBE ROTO-CUT machine.

LUBRIPLATE
FISKE BROTHERS REFINING CO.
THIS LUBRICANT INCREASED BEARING LIFE FROM 2 WEEKS TO 2 YEARS

"After we had quite a few of our large high speed ROTO-CUT meat cutting machines in actual production operation, the ball and spherical roller bearings on the cutter shaft gave us serious trouble. Some bearings did not last even two weeks.

"In an effort to correct the difficulty, we contacted a number of the large lubricant manufacturers. We tried all the lubricants their engineers recommended without the slightest success. We checked with the manufacturers of the bearings who assured us that the bearings were not overloaded. The trouble was the condition that prevails throughout the meat packing industry, animal acids and moisture, a combination most harmful to ball and roller bearings.

"Then, Ball Bearing LUBRIPLATE was called to our attention. The results we obtained from its use were most gratifying and amazing. We have had these ROTO-CUT machines lubricated with Ball Bearing LUBRIPLATE in continuous operation, twenty-four hours a day, three hundred days a year for over *two years without a single bearing replacement.* We now use LUBRIPLATE for factory lubrication and recommend it to our customers for use on practically all the equipment we manufacture."

THE GLOBE COMPANY
Frank J. Bilek (Chief Engineer)

YES, LUBRIPLATE LUBRICANTS ARE DIFFERENT! They reduce friction, wear and power consumption . . . prevent rust and corrosion and last longer than ordinary lubricants. LUBRIPLATE Lubricants are available from the lightest fluids to the heaviest density greases. There is a LUBRIPLATE product best for your every lubrication need. Write for case histories of the use of LUBRIPLATE in your industry.

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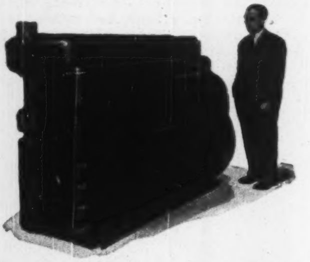
stroke, single-acting engine with a weight of about 30 lbs per hp, and a fuel consumption of 0.40 lbs per hp-hr.



Since diesel engines previously available in the 195–375 hp range have been either automotive type units at top limits of speed and rating, or de-rated, heavy, slow-speed engines, the TS diesel is said to fill a long-felt need in the industry for an engine in the 900–1000 rpm range.

This new, small-size, light-weight engine, in addition to design features of its own, includes many important design features which have heretofore been available only in much larger stationary units. Cylinders are provided with replaceable, wet-type liners and individual heads with overhead valves and intake and exhaust valve-seat inserts. The thick-wall, long-skirt pistons are of aluminum alloy, with ventilated oil-scraper rings above and below the full-floating piston pins. The perfectly balanced crankshaft is short and unusually strong, with a $5^1/_4$" diameter at both crankpin and main bearings, eliminating torsional vibration without the use of dampers.

Both the main and crankpin bearings are provided with aluminum alloy, full-floating, interchangeable shells. The camshaft, blower, water pump and lubricating-oil pump are all gear-driven from the flywheel end of the machine, permitting power take-off from either end. Individual fuel injection pumps serve each cylinder, with two, single-hole, non-clogging nozzles per cylinder. The engine is full-pressure lubricated throughout, and is equipped with a gear-driven mechanical supercharger which supplies air for increasing initial pressure in the cylinders and for scavenging during the latter part of the exhaust stroke.

Normal starting is by 250-psi air admitted to all cylinders in turn through a starting-air distributor. Other methods of starting can also be furnished. The TS Diesel is designed for mounting either on a simple concrete base, or on welded-steel skids where portability is desired.

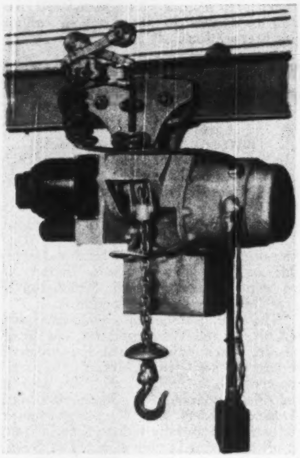
After more than two years of performance testing, the TS diesel is now in production, available in 6 or 8 in-line cylinder designs, capable of delivering 195 to 375 hp at 900 to 1000 rpm.

For literature or additional information write Ingersoll-Rand Co., 11 Broadway, New York, N. Y. or any of its branches located throughout the world.

Yale Announces Exclusively New Chain-Type Electric Hoist

Lifting speeds up to 41 feet per minute, a lower as well as an upper limit stop, and a wide "pick-up" angle, are three of the new performance features of the Chain-Type Load King Electric Hoist just announced by The Yale & Towne Manufacturing Co., Philadelphia Division.

The hoist is available in load capacities of 500, 1000, and 1500 pounds. Standard models lift loads through any height up to 40 feet. The hoist's principal distinction is that link chain, over an electrically driven sheave, supports the load. This permits extra long lifting lengths since wound-up chain does not wrap around a drum but collects in a metal container as the hook raises. Thus, for high lifts requiring long chains, all that is needed is a larger chain container—not a larger drum or multiple-layer -drum windings. The single-strand load chain securely engages six pockets of the sheave to move and hold heavy loads with a minimum of chain friction.



The hoist hook can "reach out" as far as 30° from the vertical to pick up loads. The wide pick-up angle and the flexibility of the load chain—free of twists and kinks—enables an appreciable reduction of time and power consumed in "inching" the hook up or down for close "spotting".

The limit stops prevent over-travel of the hook when lifting or lowering. They operate when the hook reaches predetermined levels and break the electrical circuit to return the push-button controller from either the "up" or "down" position to "neutral."

The hand controller is suspended by a light-gauge chain so that neither electric cable nor electrical connections take the weight of the controller. The control box is situated at a level convenient to the operator and the flexible control cable carries only switch-energizing current, and not load current.

Lower maintenance and replacement cost in the operation of the Chain-Type Load King Electric Hoist is obtained because of the longer operating life of the load chain and load sheave.

For further information on the New Chain-Type Load King Electric Hoist write The Yale & Towne Manufacturing Co., Philadelphia Division, Philadelphia, 15, Pa. Ask for the new two-page bulletin P-1172. The bulletin gives engineering specifications and technical data on all models.

New Improved Arc-Welding Electrode Announced by General Electric

A new improved arc-welding electrode, the W-52 (AWS Class E7010) a reverse polarity d-c rod, has been announced by the Welding Divisions of General Electric's Apparatus Department.

Continued on Page 60

FLOATING PYRAMID GEARS

Load distribution that is not only equal to begin with but remains self-equalizing during years of wear! That's the promise, and the practice, of Winsmith's Patented Differential Speed Reducers.

For, Winsmith's unique Floating Pyramid, a 6-gear planetary element, is free within the reducer housing to assume the most effective load distributing position. Thus it portions the load equally over a large total area of helical teeth, assuring quiet, vibrationless operation. In terms of dollars and cents value in your plant, or as a component of equipment you make, Floating Pyramid gears slash reducer maintenance and replacement costs.

REDUCTION RATIOS UNLIMITED

Whether your required reduction is 2:1 or 50,000:1 in transmitting fractional H. P. or 80 H. P., overall dimensions of the compact Winsmith Differential you select from stock, remain the same . . . the number of parts remains the same.

To make your power transmission a still stronger link in your production chain, Winsmith transmission engineers will review your present or projected power systems . . . will help gear your plant to today's demands for higher performance at lower cost, ***without obligation.***

* FREE Booklet 1949 containing complete application data and design illustrations. Write.

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WINSMITH
SPEED REDUCERS

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WINFIELD H. SMITH CORPORATION

333 JUNE ST. SPRINGVILLE, Erie County, N. Y.

All These Were Once

DUST COLLECTION PROBLEMS, TOO

48 Carbon Black Plants
203 Metallurgical Installations
205 Acid Plants • 40 Paper Mills
270 Detarring Installations
216 Power Stations
73 Steel Plants • 99 Oil Refineries
and Miscellaneous Installations

Your electrical precipitator installation will be individually engineered...and based on the Research Corporation's *experience* graphically shown by that towering pile of thousands of blue prints.

This knowledge is a valuable asset that will help Research engineers to "tailor-make" your Cottrell installation. For example, they can more quickly determine the right answers to such variables as the size, shape and type of both discharge and collecting electrodes, their relative spacing, flue arrangements and many other factors. At Research you can count on *profitable solutions to individual problems.*

Research Corporation Cottrells can be made as efficient as you desire. They can collect 95% to over 99% of all solid or liquid particles suspended in gas entering equipment. Write for free booklet giving valuable data. RC-121

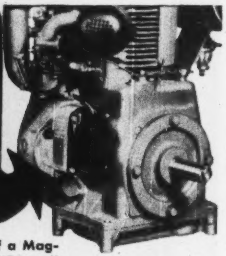
Typical One Day Collections

- 250 TONS OF FLY ASH
- 5500 POUNDS OF CONCENTRATED SULPHURIC ACID
- 6 TONS OF SODA SALTS AT PAPER MILL

RESEARCH CORPORATION

405 Lexington Ave., N. Y. 17, N. Y. 122 S. Michigan Ave. Chicago 3, Ill.

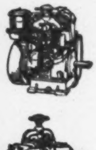
Why **WISCONSIN** HEAVY-DUTY *Air-Cooled* **ENGINES Have a Rotary-Type OUTSIDE MAGNETO**



Perhaps you have never given much thought to the placing of a Magneto on an engine, nor whether it's of the "flywheel" or "Rotary" type. It's an important point because the magneto is really the heart of the engine. When it fails, your power fails.

Wisconsin engineers have found through long experience and experimentation that the best place to put the magneto, not only for convenient accessibility but for better ignition performance over an extended period of time is on the OUTSIDE . . . with an independent, direct drive from the engine to the Magneto. The Rotary Type high tension magnetos used by Wisconsin Air-Cooled Engines provide the greatest protection against ignition troubles because the Magneto itself is a complete, independent operating unit that doesn't rely on an unrelated part of the engine for its successful operation. It's tightly sealed against dust and moisture, of course, so it isn't affected by wet weather or snow and there is no chance of it getting "fouled up". And it's equipped with an *Impulse Coupling* that provides a quick, hot spark for easy starting in any weather, in any climate, a feature that can't be incorporated in flywheel-type magneto.

Yes, the MAGNETO is important . . . both as to *type* and *placing* on the engine. It's the *right kind* and in the *right place* on Wisconsin Heavy-Duty Air-Cooled Engines. Specify "Wisconsin" for your 3 to 30 hp. power needs. . . . Descriptive literature on request.



MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 14, WISCONSIN

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The new W-52 electrode is available in $\frac{5}{32}$" and $\frac{3}{16}$" diameters for field trial. This carbon-molybdenum electrode is specifically designed for high-quality welding of low-alloy, high-tensile steels, such as pipe lines, in all positions. It can be widely applied in the welding of high-pressure piping and of castings where high tensile strength and resistance to creep at high pressures and temperatures are desired.

Good bonding action at the fusion zone on horizontal fillets and less tendency to produce pin holing on vertical down welds are characteristics designed into the new electrode.

The stable arc of the new W-52 with low spatter lends for smooth operation and eliminates tendencies to short out in confined joint preparations.

• *BUSINESS CHANGES*

Chiksan Establishes Eastern Warehouse Stock

In order to further expand its services to customers throughout the East and to speed up deliveries in that area, Chiksan Co., effective May 1st, established a warehouse stock in the Federal Storage Building, 155 Washington St., Newark 2, N. J. At the same time, the eastern headquarters for Chiksan Co. and Chiksan Export Co. are being transferred from 50 Church St., New York 7, to the Newark address.

"The establishment of a warehouse stock of Chiksan and Weco products and Okadee Loading Rack Valves in the East marks an important step in Chiksan's expansion program," says G. R. Winder, vice president and sales manager. "It will enable Chiksan to handle orders and shipments promptly and will substantially reduce time in transit on all deliveries in this area. The Newark warehouse stock will also save time in making up shipments to our rapidly expanding export outlets."

The entire New York office staff, including R. T. Jones and L. J. Smith, sales engineers and E. T. Landgraff, manager, will move to the new quarters in Newark.

Edward Research Facilities To Be Double with New Unit

East Chicago, Ind.—The new physical, chemical and metallurgical laboratories of Edward Valves, Inc., formally opened less than a year ago, are being increased nearly fifty percent in size with the construction of a new unit, for which ground was recently broken.

The addition will house Edward-designed special mechanical testing equipment for Edward and Nordstrom valves. The building is being constructed on three levels to facilitate operation of equipment which will duplicate actual service conditions now prevalent or anticipated in the steam power plant, petroleum and chemical fields.

Essentially all the new expansion will be devoted to testing valves and piping under fluid flow. Test boilers, compressors, pumps and other equipment will permit the uses of gases and liquids at pressures up to 5,000 lb and temperatures up to 1,500 degrees.

When the new Edward laboratories were opened last summer, research facilities were tripled. Especially constructed stress, creep and pressure drop testing units were installed at that time and will be continued in their present locations.

Edward, a subsidiary of the Rockwell Manufacturing Co., manufactures cast and forged steel valves for service from 150 to 7500 lb. The research laboratories, in addition to projects for Edward, are also used to augment laboratory facilities of the Nordstrom Valve Division of Rockwell, which maintains a chemical and physical research department in Oakland, California.

The development of the Edward research department into one of the largest in the United States for a manufacturing company of comparable size, has been under the direction of W. F. Crawford, Edward President, and L. H. Carr, Director of Research.

New York Representative for Keckley

The O. C. Keckley Co., 400 West Madison St., Chicago, Ill., announce the appointment of the Stanley Sales Company, 1440 Broadway, New York City, as their industrial representative in the New York territory for their line of Float Valves, Pressure Regulators, Temperature Regulators, Water Gauges, Gauge Cocks, Steam Traps, and Strainers.

Foote Bros. Appoints Representative in Dallas, Texas

Foote Bros. Gear & Machine Corp., Chicago announces the appointment of Associated Air Service of Dallas, Texas, to represent the Precision Gear Division in the sales and service of A-Q (aircraft quality) Gears, Actuators and Power Units in the states of Kansas, Oklahoma, Texas, Missouri and Arkansas.

Associated Air Service will handle application engineering of Foote Bros. products, particularly as they relate to the aircraft industry.

J. A. Cleeland is the head of Associated Air Service and has had many years of experience both in the fields of aircraft and air transportation. The address of Associated Air Service is 234 Terminal Bldg., Love Field, Dallas, Texas.

Five New Chiksan Representatives

The appointment of five new Chiksan representatives is announced by G. R. Winder, vice president and sales manager, Chiksan Co., Brea, Calif. Robert S. Hudgins, Jr., 118 North Chase St., Charlotte, N. C., will cover North and South Carolina. The Southern Corp., Charleston, S. C., will continue to represent Chiksan in the pulp and paper industry in these states. R. S. Stover Co., Kresge Bldg., Marshalltown, Iowa, has been appointed to cover the states of Iowa and Nebraska, the Geo. S. Thomson Co. Inc., 915 South Central Ave., Phoenix, Ariz. will cover the state of Arizona, the Jos. W. Eshelman & Co., Inc., 2625—6th Ave. South, Birmingham 5, Ala., covering Alabama and parts of Tennessee and Florida, with the Rittelmeyer & Co., Inc., 150 Nassau St., N. W., Atlanta 1, Ga. covering the entire state of Georgia and a part of Florida.

"The appointment of these representatives," says Mr. Winder, "is in line with Chiksan policy to extend field contacts through trained representatives who are equipped to work closely with engineers and operating men on problems pertaining to flexible lines for all purposes."

• *LATEST CATALOGS*

Spreader Stoker

Bulletin 8028 describes an improved type of spreader, having a forward moving grate that slowly and continuously discharges the ash at the front. High burning rates permit increased capacities. All grades of bituminous coal or lignite successfully burned. Superior continuity of performance demonstrated. Detroit Stoker Co., Detroit, Mich.

Rack Rake

Newport News Shipbuilding & Dry Dock Co., Newport News, Va., offers a fifteen-page booklet containing illustrations and standard arrangements for the use of the Newport News Mechanical Rack Rake. A power operated rake for cleaning trash racks at water intakes for hydroelectric plants, steam plants, pumping stations, canals and similar installations.

Hallowell Foreman's Desks of Steel

Standard Pressed Steel Co., Jenkintown, Pa., announces the availability of their new, improved "Hallowell" Foreman's Desks of Steel. Three standard models from stock . . . of sturdy, all-steel construction with baked-on enamel finish. Smooth, firm writing surface won't dent. Drawers glide easily on ball-bearing rollers, lock securely. "Pigeon-hole" tops keep work neat and orderly. Complete details contained in new Bulletin 721.

Armco Metal Drainage Structures

A colorful illustrated folder describing the strength advantages of Armco metal drainage structures has been published by Armco Drainage & Metal Products, Inc. Entitled "Here's the 'Strong Man' to Handle Your Drainage Problems," the folder points out that three kinds of strength—continuous beam strength, strength to support loads and resist impact, and joint strength—enable metal structures to meet the job needs of highway, railway, airport, municipal and industrial service.

Photographs and diagrams show that flexible metal underground structures can support heavy live and dead loads without failure. Beam strength, permitting the use of long lengths, and strength and durability of joints in both pipe and Multi Plate structures are also discussed.

A listing of Armco drainage structures outlines the types suitable for various installations and kinds of service.

Copies of the pamphlet can be obtained by writing to Armco Drainage and Metal Products, Inc., General Offices, Middletown, Ohio.

Non-Clogging Centrifugal Pumps

Economy Pumps, Inc., of Hamilton, Ohio, now has available a revised catalog of non-clogging centrifugal pumps. The pumps featured in this catalog are designed to pass liquids containing solids from 2 to 10-inches in diameter; capacities range from 50 to 20,000 U. S. gallons per minute.

Applications for these types of pumps include sewage disposal, flood control, reduction, drainage of liquid containing sand or silt, food pulp distribution, and use in paper mills for stock pumping, water supply, and overflow. Complete selection table included in catalog No. F-249, Economy Pumps Inc., Hamilton, Ohio.

Grinnell Seamless Carbon Steel Welding Fittings

A new 88-page, working catalog, packed with information on Grinnell seamless carbon steel welding fittings and forged steel flanges is available for free distribution. In addition to presenting standard schedules with their specifications, list prices and sizes, this new catalog gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings stocked in other metals such as stainless steels,

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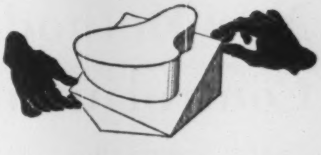

The shape's the thing . . .

The selection of a suitable steel and its subsequent satisfactory performance can be made easy by good design.

How and in what shape a part is made is, we hold, of fundamentally greater importance than of what it is made.

In designing a piece of machinery it is necessary to consider Design, the choice of steel, and its Heat Treatment. All three are highly significant factors, but of them we believe Design to be vital because even the best in steel and treatment will not save a poorly designed part.

To evaluate the importance of good design and its vital relationship to the selection of steel and its heat treatment, we have prepared a book—"Three Keys to Satisfaction". This starts by discussing mainly design factors involved in stress concentrations, and includes useful sketches comparing poor and good features of design from the aspect of subsequent metallurgy. It is available on request to all engineers and designers.

Climax Molybdenum Company

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New York City

Please send your
FREE BOOKLET
3 KEYS TO SATISFACTION

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Position..........
Company..........
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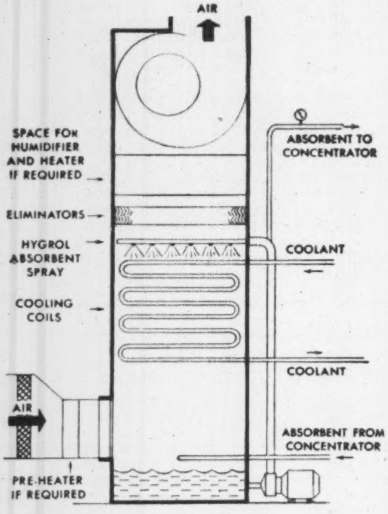
MOLY

ME6
● F17

New Method Gives Precise Control in Air Conditioning

Niagara "Controlled Humidity Method" Uses Hygrol, Hygienic Liquid Absorbent


AIR
SPACE FOR HUMIDIFIER AND HEATER IF REQUIRED
ELIMINATORS
HYGROL ABSORBENT SPRAY
COOLING COILS
AIR
PRE-HEATER IF REQUIRED
ABSORBENT TO CONCENTRATOR
COOLANT
COOLANT
ABSORBENT FROM CONCENTRATOR

NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

● The Niagara "Controlled Humidity Method" is a new system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required. A condition of 15 grains of moisture per pound of air at 85 deg. F. dry bulb temperature has been produced without refrigeration.

The apparatus is enclosed in a casing thru which the air is drawn by fans. The air is filtered and then enters a chamber where it is dehumidified in passing thru a spray of "Hygrol" Liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate). In the same chamber are located cooling coils which remove the latent heat of evaporation and also sensible heat as required.

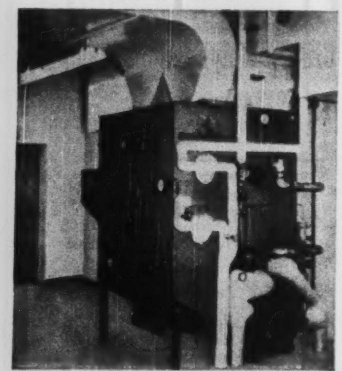
The absorbent liquid spray falls into a tank at the base, where it is piped to a concentrator, removing moisture taken from the air. The re-concentrated liquid returns to the system. This process is continuous, and the apparatus operates at full capacity at all times.

The same equipment may be used to provide winter air conditioning when required, by installing a tempering coil at the outdoor intake, an humidifier, and a reheat coil above the eliminators.

This equipment is manufactured in a range of sizes providing from 1000 to 20,000 CFM of conditioned air from a single unit, and mutiple unit installations are practical. It is expected that, by reducing the need for refrigeration, the cost of air conditioning will be reduced by this method. Applications generally are in a temperature range from 35 deg. F. upward. Below the freezing temperature of water, the Niagara "No-Frost" method is applicable.

The equipment is protected by U. S. and foreign patents. Installations have been made in food and chemical process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control and for human comfort.

For further information, write Niagara Blower Company, Dept. ME, 405 Lexington Ave., New York 17, N. Y.



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Inconel, pure Nickel or Monel, Aluminum, deoxidized red brass, with admiralty bronze and other copper alloys available on request.

Your copy of this new catalog will be sent in response to your request addressed to Grinnell Co., Inc., Providence 1, R. I. or any of its offices and warehouses in the principal cities from coast to coast.

Standardizes Control Connecting Linkage

Now you can reduce installation costs by ordering control connecting linkage and accessories by stock number.

Because of the flexibility of its control drives, Bailey Meter Co. has been able to standardize on relatively few sizes and styles of control connection linkage. The company has issued a 16-page brochure which contains all information necessary for choosing and ordering the correct material and arrangement to suit almost any application.

Write to Bailey Meter Co., 1026 Ivanhoe Road, Cleveland 10, Ohio and ask for General Specification CA942 "Bailey Control Linkage".

New Booklet Describes Photographic Processes for Business, Industry

Applications of photography in business and industry are summarized in a new, 16-page booklet published by the Eastman Kodak Co., Rochester 4, New York.

Entitled "Functional Photography in Industry," the book describes processes and techniques applicable to a wide range of endeavor.

The text, prepared in non-technical language, sums up these methods and the results yielded by them. Numerous illustrations depict their use for research, production, quality control, training, advertising, and sales.

A simple form is provided to request more detailed information regarding any of the processes summarized.

The booklet is available without charge from the Industrial Photographic Division, Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

Assembling and Finishing Carbide Header Dies

With increasing use of header dies employing carbide die nibs for heading of bolts, screws, rivits, etc., Carboloy Co., Inc., 11183 East 8 Mile Road, Detroit, Mich., has issued a 4-page bulletin (#D-127) giving detailed instructions for assembling and finishing such dies.

Included in the leaflet is information on the preparation of the rough nib for assembly; heat treatment of steel die case; method of finishing case; assembly of nib in case; etc. The various steps—including the preparation of solid and split laps—are visualized by means of line drawings. A nomograph for the rapid determination of the amount of press fit required for the assembly of any given size of header die nib in a steel case, is included.

Single Stage Mechanical Drive Turbine

New Bulletin contains a complete description and specifications of a new single stage mechanical drive turbine suitable for pressures to 1450 psig, initial temperatures to 950 F.T.T. and back pressures to 300 psig. The CP turbine is the first standard single stage mechanical drive turbine to be designed especially for high pressure service. The labyrinth shaft seal used in the CP turbine consists of a series of shaft grooves

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and mating tongues of stainless steel packing. The number of labyrinths in the shaft depends upon the exhaust pressure rating—as many as 52 labyrinths per side being employed for the highest pressures. This prevents leakage effectively, reduces losses, lasts longer and requires less maintenance.

To provide for extreme thermal expansion encountered in high temperature service, the turbine is supported at the true centerline and the front end is mounted on a flexible channel. This method of mounting permits both radial and axial expansion to take place without disturbing the shaft centerline.

The turbine can be furnished with any of eight different types of governors to meet all control requirements. They include: mechanical shaft, vertical flyweight with or without oil relay, hydraulic with or without oil relay, pressure governors for pump and blower drives and auxiliary tripping devices. A separate trip operating independently of the governing system gives positive protection against overspeeding.

The De Laval CP turbine is made in three sizes for capacities up to 2000 HP.

Copper Alloy Specifications Index

A new, up-to-date 1950 edition of "Copper and Copper Alloy Specifications Index" has been announced by The American Brass Co. The first edition of this 28-page booklet was published two years ago as a time-saving convenience for those using standard specifications of Engineering Societies and Government Agencies.

In two sections, the first part lists Anaconda's most generally used alloys, together with all applicable specifications. Section II lists specifications in numerical order with a brief description of materials covered as to grade, type, temper, anneal, etc. Both sections are side-indexed for ready reference.

The new 1950 Index is available without change. Write The American Brass Co., Waterbury 20, Conn., or any district office, asking for Publication B-34, Third Edition.

Automatic Control of Traveling Screen Cleaning

A schematic installation drawing and a typical wiring diagram are among the engineering details included in a new Application Engineering Data Sheet covering control of cleaning cycles for traveling screens. Copies of the Sheet 821-1 are available from The Foxboro Co., 182 Neponset Ave., Foxboro, Mass., upon request.

The system, already in use in a large number of prominent power plants, steel mills, and other large water users depends upon the measurement of hydraulic loss across the trash rack and traveling screen.

It initiates automatic cleaning for a regular cleaning cycle. If, for any reason, the cleaning fails to reduce the loss across the screen, emergency alarms are provided to warn operators of unusual operating conditions.

Process Pumps

New De Laval Type CP Process Pump Bulletin which describes the new line of De Laval Type CP process pumps designed for handling hot or cold clear liquids, viscous liquids, corrosive liquids or liquids carrying suspended solids. Vane characteristics and materials of construction can be selected to suit requirements. Capacities range from 15 to 600 gpm for heads of 15 to 240 feet. The bulletin contains a cross-section showing both open and enclosed impeller designs along with features such as: eductor

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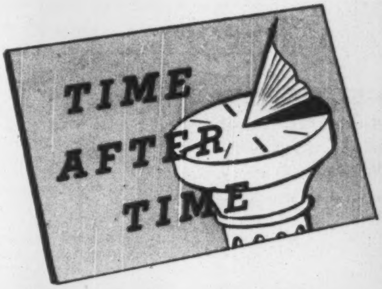
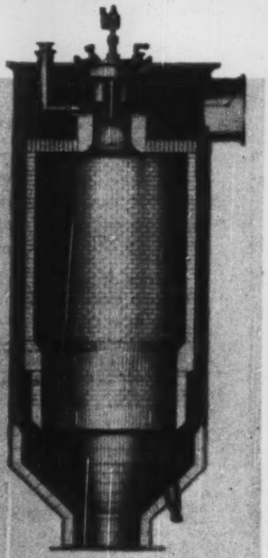


leading industries specify

PEABODY

Direct Fired Air Heaters



Repeat installations in a wide variation of industries ranging from catalytic cracking to spray drying and odor eliminating, at home and abroad, prove beyond doubt the effectiveness and efficiency of Peabody Direct Fired Air Heaters.

Equipped for oil, gas or combination firing, they are available in sizes ranging from 1,000,000 to 100,000,000 BTU/hr with pressures ranging up to and above eight atmospheres. Simple, centralized control. Compact design saves space and permits horizontal, vertical up-draft or vertical down-draft firing with inlet and outlet connections sized to fit present ducts.

Write for Bulletin No. 600 for complete details!

PEABODY PRODUCTS INCLUDE: Automatic Gas and Oil Burners • Pump and Heater Sets • Direct Fired Air Heaters • Gas Scrubbers, Coolers and Absorbers • Burners, singly or in combination, for firing Oil, Pulverized Fuel, and Gas (manufactured, natural, refinery or blast furnace).

511

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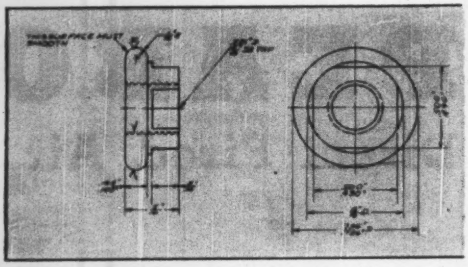
ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK 19, N. Y.
Manufacturers of all types of combustion equipment, direct fired air heaters, gas scrubbers, coolers and absorbers

PEABODY LIMITED • LONDON, S.W. 15, ENGLAND

with STEEL CABLE
— the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished structure.



with TRACING CLOTH . . .

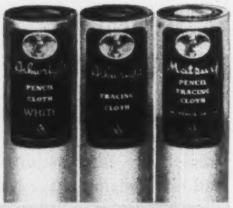
— the small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Lines drawn on Arkwright Tracing Cloth stand out with unusual clarity — a clarity that is permanent because Arkwright does not become opaque or brittle with age. Special mechanical processing, plus sturdy uniform threads expertly bonded, protect your investment through years of service. Perishable tracing paper cannot safely promise this.

Arkwright Tracing Cloths are preferred by foresighted drafting departments *for every drawing worth keeping for future use.* Send for generous samples. Sold by leading drawing material dealers everywhere. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.



ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

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vanes on back of impeller to reduce end thrust and stuffing box pressure; permanently lubricated bearings; external adjusting screw to compensate for wear at impeller face; and provision for easy conversion from packed to mechanical seals. The bulletin also contains capacity and head range diagrams for 1750 and 3500 rpm speeds, along with a dimension table.

Another feature of this line of pumps is that they can be easily converted from open to enclosed impeller if service requirements change. They have also been carefully designed to keep spare parts to a minimum. Two sizes of shafts, shaft locknuts, bearings, bearing cartridges and pedestals are all that are required for the entire line of seven pumps.

For additional information, write to Advertising Department, De Laval Steam Turbine Co., Trenton 2, N. J.

Engineering Organization "Re-Engineered" to Meet New Processing Problems

How the M. W. Kellogg Co. has reorganized its engineering departments to anticipate the increasing complexity of engineering modern processing plants is told in detail in "Kelloggram" No. 2, 1950, just published by this chemical and refinery engineering concern of Jersey City, N. J.

Accordingly to Kellogg, the "re-engineering" of the departments was accomplished in a relatively short period because plans and studies had been completed during the war and post-war years when industrial organizations as a whole were generally upset by rapid expansion and development of new processes.

The establishment of new concepts and granting of special authority to planning groups have done much to simplify the engineering of refinery projects, the "Kelloggram" states. In the planning stage alone, for example, Kellogg estimates that engineering expense is cut about 25% due to the all-important engineering factors—layout, vessel elevations, pipeway arrangements, and so on—that are agreed upon with the customer prior to the start of any detailed engineering.

Charts showing the new setup, breakdowns of responsibilities, and a general picture of how the various subdivisions all work together to create an actual plant from the data provided by process engineers, are covered in this issue.

New John Crane Lapmaster Booklet on Lapping to Extreme Tolerances

A valuable booklet fully illustrating and describing the new "Lapmaster" method of flat lapping to extremely close tolerances on an automatic, high production basis is just off the press, and is available on request. Photographs, diagrammatic drawings, and complete data on John Crane Lapmaster Models "12" and "24" provide profitable information for all industries whose manufacturing operations include finishing parts to precision surface flatness and RMS finish.

The Lapmaster Lapping Machine, a remarkable new John Crane development recently introduced by Crane Packing Co., has attracted wide attention. It is applicable to both production runs and individual jobs. It can be operated by unskilled workmen. One of its outstanding features is the continual self-conditioning of the lapping plate during the lapping cycle—thus eliminating lost time for reconditioning.

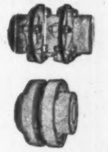
Among the special points of interest in the new booklet are: detailed explanation of the

THOMAS
Flexible ALL METAL
COUPLINGS
FOR POWER TRANSMISSION
REQUIRE NO MAINTENANCE

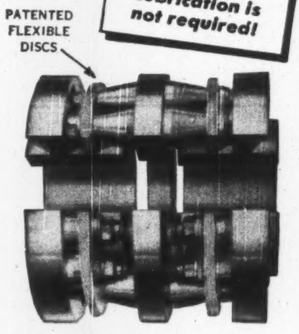
Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years



BACKLASH
FRICTION
WEAR and
CROSS-PULL
are eliminated
Lubrication is not required!



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.

NO MAINTENANCE PROBLEMS.

ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

THOMAS FLEXIBLE
COUPLING CO.
WARREN, PENNSYLVANIA

• Keep Informed

operation of the Lapmaster; actual production results obtained by users; photographic illustrations of many types of parts successfully lapped in production runs; a chart enabling the reader to make a preliminary production estimate of his work when finished on the Lapmaster; full specifications for Models "12" and "24" Lapmasters.

A section of the book is devoted to Lapmaster accessories. These include precision flatness-measuring Monochromatic Lights and Optical Flats, lapping compounds, polishing plates and hand-lapping plates.

Copies of this new booklet may be had, free of charge, by writing the manufacturer. Crane Packing Co., Dept. H-1, 1814 Cuyler Ave., Chicago 13, Ill.

New Proportioning Bulletin

A new, three-color, six-page bulletin (No. 3849) has just been made available by the Richardson Scale Co. of Clifton, N. J. It describes the company's new, precise proportioning and blending system, heart of which is the Conveyometer, a self-testing Feeder-Weigher designed for "stream" delivery of small, crushed, granular or nonflushing, ground materials.

It is ideal for proportioning any number of materials such as grains, feeds, meals, coffee, sugar, sand, soda ash, crushed rock, coal, coke, ore, and powdered chemicals in a continous process of mixing and blending. It can be used also for delivering a prescribed tonnage of material by weight from supply to process and for recording the tonnage of material passed over it with suitable controls.

Each load can be weighed in any number of cycles, up to ten per minute, thus providing a practically continuous stream of material. An example of the ten cycle per minute run is schematically illustrated in Bulletin No. 3849, with a battery of ten Conveyometers, each feeding a different material to complete a prescribed blend. Visual indicators signal over-weights, underweights and proof of automatic corrections.

This choke proof, dustproof scale is capable of handling a wide range of loads at varying capacities.

The manufacturer will be glad to furnish complete details.

Magnesium Anode Data

"Combatting Corrosion"—This is a general information bulletin on the using of magnesium anodes for cathodic protection of industrial equipment, pipe lines and other metal structures. This new, colorful and illustrated booklet covers applications of cast, packaged, flexible ribbon and extruded magnesium anodes. This bulletin gives composition of magnesium alloy, includes rating, dimensions, sketches, prices and case histories. Dowell Incorporated, Kennedy Bldg., Tulsa 3, Okla.

Henszey
Continuous Blowdown System

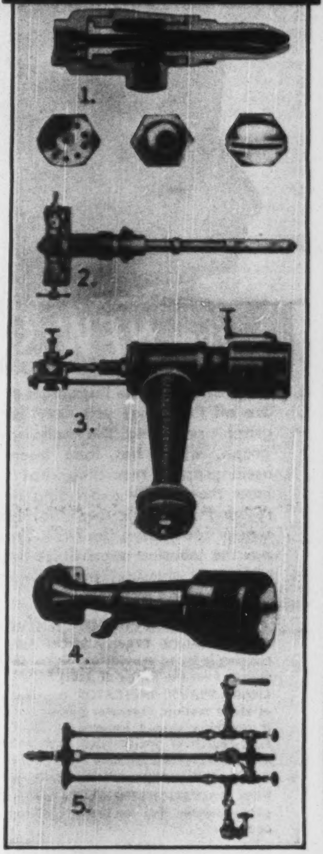
A new folder and chart has been recently prepared by The Henszey Co., Watertown, Wis., to show plant engineers how to determine the proper size continuous blowdown system for an installation.

The chart takes into consideration such variables as impurities in feed water, desired concentration in the boiler, amount and temperature of makeup and boiler pressure.

Size of the required blowdown system is read directly from the chart. It shows annual fuel savings effected by blowdown heat exchangers based on an average fuel cost and boiler efficiency. Corrections to specific costs are easily made.

Continued on Page 66

THE *RIGHT* OIL
BURNER OR GAS
BURNER FOR YOUR JOB



TYPE "S-A"
1. (For use where steam is available) *atomizes thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures. Send for Bulletin No. 21.

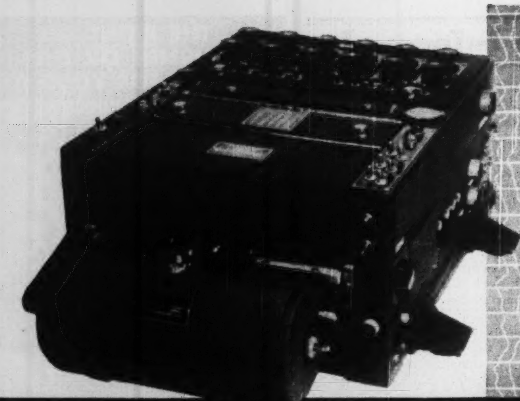
TYPE "S-A-L"
2. (Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers. Send for Bulletin No. 24.

COMBINATION
GAS AND OIL
BURNER
3. —the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner. Send for "Airocool" brochure.

"AIROCOOL"
GAS BURNER
4. (Of venturi type) assures low turndown without burnback. Send for "Airocool" brochure.

TYPE "S-A-D"
5. (Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc. Send for Bulletin No. 21.

NATIONAL AIROIL BURNER CO., INC.
Main Offices and Factory:
1239 E. SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard
Houston 6, Texas



the *NEW* S-8 Oscillograph

Here, in a versatile instrument of advanced design, are all the things you need for complete oscillographic recording. The Hathaway Type S-8 Oscillograph, which has long been the standard of oscillographic recording, has been improved to meet the rapidly expanding demands of modern research. Whether your measurement problems are simple or complex, the NEW Type S-8 Oscillograph has the inherent capabilities necessary to measure vibration, pressure, acceleration, and strain with new ease and accuracy.

The newest features include:

QUICK-CHANGE TRANSMISSION *fully enclosed with gears running in oil* to provide instantaneous selection of 16 record speeds over the range of 120:1

CHART TRAVEL INDICATOR provides continuous indication of chart motion. Operator knows instantly by flashing lamp if anything should happen to interfere with chart motion

FULL-RESILIENT MOUNTING FOR MOTOR AND TRANSMISSION isolates all possible vibration and makes possible the use of modern super-sensitive galvanometers

NEW GALVANOMETER STAGE accommodates *all* Hathaway galvanometer for recording milliamperes, microamperes, or watts

NEW RECORD-LENGTH CONTROL AND NUMBERING SYSTEM designed for long, trouble-free service under all kinds of ambient conditions

All the other valuable features are retained, such as

PRECISION TUNING-FORK-CONTROLLED TIMING SYSTEM produces either 1/10-second or 1/100-second time lines across sheet

WIDE RANGE OF GALVANOMETER TYPES AND CHARACTERISTICS provide for almost any recording requirements. Natural frequencies to 10,000 cps. Sensitivities to 50,000 mm per ma, single and polyphase watts

DAYLIGHT LOADING AND UNLOADING RECORDS TO 200 FT. IN LENGTH, width to 10 inches

SIMULTANEOUS VIEWING AND RECORDING

AUTOMATIC BRILLIANCY CONTROL

12 TO 92 ELEMENTS

Whatever your needs may be, investigate the NEW Type S-8 Oscillograph and its 170 types of galvanometers — the most versatile equipment in existence for general-purpose applications.

WRITE FOR BULLETIN 2B1-K

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

• Keep Informed

The method of determining the size of a continuous blowdown system can also be applied to single and multiple stage heat exchanger units.

Comments on the advantages and disadvantages of various types of installations are also made to assist the engineer in arriving at the most economical blowdown system for his plant.

The information contained in this folder is invaluable to plant engineers. Copies of it may be obtained free of charge by writing directly to The Henszey Co., Watertown, Wis.

Air and Hydraulic Information

A new booklet describing the application of air and hydraulic power has just been published by Rivett Lathe & Grinder, Inc., It is devoted to showing a number of circuit diagrams indicating how air and hydraulics may be efficiently applied to industrial equipment.

The $8^1/_2$" × 11" booklet is aimed at providing a more complete understanding of air and hydraulics and the many possibilities of using these types of power. It tells how the great strides made in manufacturing air and hydraulic equipment, utilizing the improvements in materials, has made possible a variety of devices for application to machinery and equipment to eliminate manual effort, achieve greater economy, and cut time substantially.

For copies of the new 8-page booklet, write to Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass., mentioning this magazine.

Electric-Resistance-Welded Steel Boiler Tubes

A new bulletin of technical data on electric-resistance-welded steel boiler tubes has been announced by The Babcock & Wilcox Tube Co. For convenience in ordering, tables are furnished on maximum allowable working pressures, conforming to ASME Specification SA-178, for different diameters and gages of tubes for water-tube and fire-tube boilers. Another table determines the weight in pounds per lineal foot of steel tubes in various minimum wall sizes.

The bulletin, TB-331, is available free on request to The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

New Float and Lever Valve Selection Chart

A handy new float and lever valve selection chart is available from Klipfel Valves, Inc., Division of Hamilton-Thomas Corp., Hamilton, Ohio. The chart, like the company's reducing valve guide, is useful to anyone who has to specify valves occasionally and who does not have all the engineering background necessary to do the job easily.

By reference to the service for which the valve is intended, the maximum pressure drop between inlet and outlet, maximum temperature, and other factors, selection of the correct valve can be made easily and expertly.

Used in conjunction with Klipfel Float Valve Bulletin No. 349, the chart also helps determine proper sizes of valves. Too often valve sizes are determined solely from pipe sizes, usually resulting in a valve much too large for the required flow. Such oversize valves will operate in a nearly closed position and are subject to wire-drawing and chattering. If the valve closes "with the flow", over-sizing or excessive pressure drop may cause the valve to slam.

The chart also clearly indicates which valves are suitable for deadend service and which are not. Klipfel engineers have found that in many cases, valve users will specify for deadend service valves which are not tight closing. The valves thus chosen prove to be unsatisfactory, of course, and often dangerous to the users.

Copies of the new valve selection chart and Float Valve Bulletin No. 349 are available from Klipfel Valves, Inc. on request.

Pneumatic Cylinders

Bulletin CS-349 released by Ledeen Manufacturing Co., Los Angeles, Calif., describes the application of eleven pneumatic cylinders on a Pony Trimmer in a Vancouver, B. C. lumber plant.

Unusual efficiency is obtained in the selection and cutting of lumber into best commercial grade lengths. The bulletin describes the application, cylinder equipment and installation. Copies are available through this publication or Ledeen Manufacturing Co., 1600 So. San Pedro St., Los Angeles 15, Calif.

Care of AC Rotating Equipment

To promote intelligent and consistent maintenance of electrical machines, Allis-Chalmers is making available in booklet form a series of articles by Fraser Jeffrey, assistant to the company's chief electrical engineer, entitled "Care of AC Rotating Equipment."

Contents of the 24-page booklet are broken down broadly into preventive maintenance and machine repairs. Under the former, such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and proper machine applications are covered. Machine repair includes data on stator coil and slip ring rotor repairs and balancing of rotating equipment.

The author holds that effective maintenance requires familiarity with an understanding of the structural and operating needs of a machine, knowing what to do, when to do it, and the establishment of a maintenance schedule rigidly adhered to.

Copies of "Care of AC Rotating Equipment," 05R7417, are available upon request from Allis-Chalmers Manufacturing Co., 949 S. 70th St., Milwaukee, Wis.

Hallowell "700" Steel Platform Trucks

Standard Pressed Steel Co., Jenkintown, Pa., announces the availability of Bulletin 718 on their new Hallowell "700" Steel Platform Trucks. This Bulletin contains full information, illustrations and tables as to: Attractive Features; Sizes and Types; Load Ratings (plain tread wheels—rubber-tired wheels); How to Order; etc. The 3 general Truck models are discussed completely, whether Light Duty, Medium Duty or Heavy Duty. Also, the back cover illustrates the Stock Cart and Special Trucks.

Facilities and Products

Newport News Shipbuilding & Dry Dock Co., Newport News, Va., announces a forty-page bulletin containing illustrations and information on the facilities and products other than shipbuilding of the Newport News company. Steel fabrication, subassembly methods, sheet metal facilities, machine shops, forging, and foundries are featured in the publication.

Spreader Stoker

Bulletin 828 describes Spreader Stoker with overthrow Rotor that provides exceptionally uniform fuel distribution. Stationary, hand dumping or power dumping grates. Many sizes assure efficient application to all types of boilers and steam generators. Detroit Stoker Co., Detroit, Mich.

Cuts Maintenance Costs

This is a general information bulletin on Dowell Incorporated Service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of the services are presented and the bulletin treats in detail the methods used to remove incrustations from the internal surfaces efficiently and economically with a minimum of downtime. Dowell Incorporated, Kennedy Bldg., Tulsa 3, Okla.

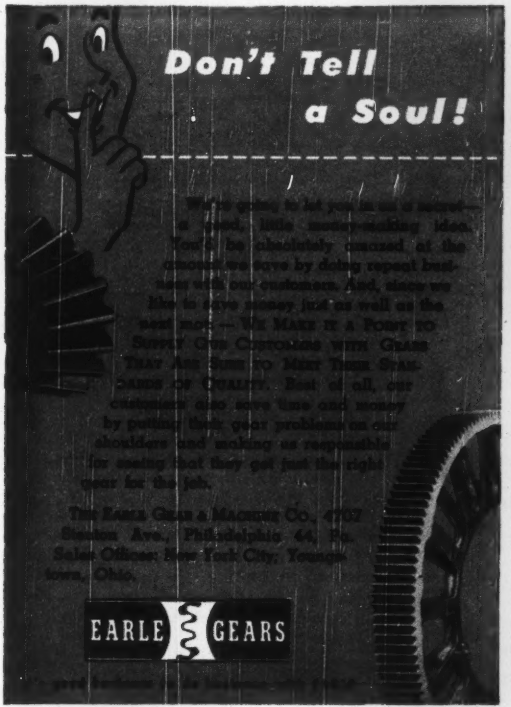
Gas Analyzer Described in New Bulletin

An improved type of gas analyzer for measuring CO_2, O_2 and CO is described in Bulletin 120 just released by the Ellison Draft Gage Co., 214 W. Kinzie St., Chicago 10, Ill.

Flue gases from boilers are analyzed to determine effectiveness of combustion, quality of fuels and other data. These units are made of corrosion-proof parts including a Monel carrying case. Thermometer in carrying case is also included.

Issued simultaneously is Bulletin 118 covering the Ellison U-Path Steam Calori-

Continued on Page 68


Don't Tell a Soul!

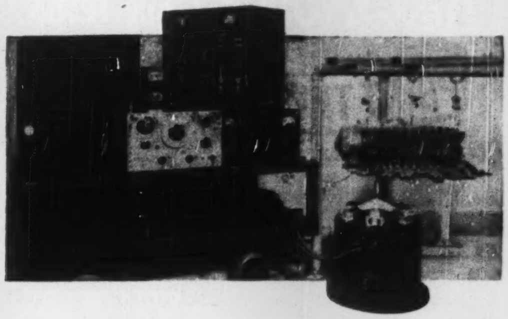
We're going to let you in on a secret—a good, little money-making idea. You'd be absolutely amazed at the amount we save by doing repeat business with our customers. And, since we like to save money just as well as the next man — We Make it a Point to Supply Our Customers with Gears That Are Sure to Meet Their Standards of Quality. Best of all, our customers also save time and money by putting their gear problems on our shoulders and making us responsible for seeing that they get just the right gear for the job.

The Earle Gear & Machine Co., 4707 Stenton Ave., Philadelphia 44, Pa. Sales Offices: New York City; Youngstown, Ohio.

EARLE GEARS

[illegible]

YOU CAN BE SURE.. IF IT'S Westinghouse



Explore . . . Test . . . Remedy

It pays off to fatigue test materials *before* production starts. Westinghouse Type HI Vibration Fatigue Equipment, illustrated above, has been designed to supply the resonant drive force needed in fatigue testing operations. Write for complete information on this or other vibration testing equipment. Westinghouse Electric Corporation, Department E-1, 2519 Wilkens Avenue, Baltimore 3, Maryland.

J-02210

TYPE JC-1 VIBROMETER
TYPE HQ PORTABLE BALANCER
TYPE MH VIBROMETER
TYPE LE VIBROGRAPH

Westinghouse
VIBRATION EQUIPMENT

meter which combines a throttling separating and re-evaporating calorimeter in a single chamber, having the remarkable accuracy of within 2° F of the theoretical temperature. This unit effectively determines the percentage of moisture in steam and also determines the quality. Either or both bulletins are available on request.

Onsrud Air Turbine Portable Grinders

The new Bulletin 1129 on Onsrud Air Turbine Portable Grinders has just been completed and released for distribution. The bulletin describes and illustrates all Onsrud Air Turbine Portable Grinders . . . the 1/6 HP, 75,000 RPM Model B-1 . . . the 1/4HP, 50,000 RPM Model D-1 . . . and the 1/2 HP, 38,000 RPM Model E-1. Also shown is the precision Onsrud D1-S Hole Grinder attachment for jig borers, boring mills and similar machines. Of interest also will be the complete page describing Onsrud Industrial Air Turbine Motors. Tool and equipment manufacturers requiring a high speed motor for grinding operations and other uses will find this page of extreme interest.

Write Onsrud Machine Works Inc., 3917 Palmer Street, Chicago 47, Illinois, and ask for your copy of Bulletin 1129.

Oil Seals

New Brochure, "Johns-Manville Clipper Seal", is a sixteen-page handbook of useful data for anyone needing information on oil seals. Photographs show where to use Clipper Seals and how to install them. Drawings illustrate how the lip and heel construction of these non-metallic oil seals can be varied. The text gives other pertinent information of importance to designers, engineers, and maintenance men. The booklet is divided into sections on the principle of Clipper Seals, their construction, advantages in various applications, installation data, and other information of interest to oil seal users.

Free copies of this publication are now available from Johns-Manville, 22 East 40 Street, New York 16, N. Y.

Sonntag Fatigue Machine

Bulletin 313, which describes the Model SF-4 Sonntag fatigue machine of plus or minus 5000 lb. capacity, is announced by The Baldwin Locomotive Works, Testing Equipment Department, Philadelphia 42, Pa. This 2-page bulletin tells how the testing machine works, gives specifications, and contains illustrations showing both external and internal equipment, controls and operating mechanism.

Economy of Mechanical Tubing

A new bulletin on mechanical tubing is announced by The Babcock & Wilcox Tube Co. It describes ways in which increased production, lower manufacturing costs and short cuts to improved design may be reached by taking advantage of an unusual service embracing the complete range of steel tubing available to industry. This includes seamless, as well as welded, tubing, hot-finished or hot-rolled, cold-drawn or cold-rolled, in carbon, alloy and stainless steel grades, in various finishes, and heat treated for optimum ease of machining, joining and forming operations. The bulletin also shows how purchasing problems may be simplified.

Bulletin TB-324, is available on request to The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

Water Power Equipment

Newport News Shipbuilding & Dry Dock Co., Newport News, Va., offers a seventy-five page booklet containing photographs and data on many of the hydroelectric developments for which Newport News has furnished equipment. Contains other information regarding the construction of many items of water power equipment.

New "Packaged" Lead Encasing Press

A 4-page brochure has just been prepared by John Robertson Co., 121–137 Water St., Brooklyn 1, N. Y., which illustrates and describes their new self-contained ("Packaged") Oil-Hydraulic Lead Encasing Press. This press has been developed with many innovations for use by the Cable and Rubber Hose Industries. A copy of the brochure will be sent upon request to the company.

De Laval Herringbone Speed Reducers

New De Laval Herringbone Gear Reducer Bulletin which covers a new line of heavy duty herringbone gear reducers for capacities up to 1000 HP. It contains complete descriptions of single, double and triple reduction units, complete horsepower rating tables for standard and semi-high speed units, overhung load rating tables, dimensions and weights. A "selection" section tells how to select herringbone gear reducers and also gives examples.

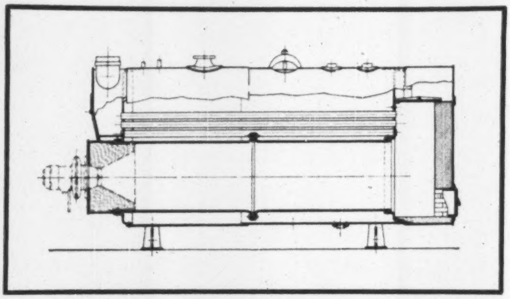
VIBRATION Fatigue Tests
POINT THE WAY TO IMPROVED PRODUCTS

MODEL 100VA
CAPACITY 100 Lbs.
Produces Vibrations Vertically

You can be sure if your products pass a vibration fatigue test—substantiates design and construction materials—frequently exposes excessive material. Many things can be learned from tests. A "must" for electronic, aircraft and automotive parts and assemblies. Hundreds in use. Models to handle parts from 10 lbs. to 100 lbs.—choice of vertical or horizontal table movement. Frequencies of 600 to 3,600 v.p.m. Special machines to order. Catalog F contains treatise.

Made by the makers of All American 16X Microscope for carbide surface inspection

ALL AMERICAN
Tool & Manufacturing Co.
1016 FULLERTON AVE., CHICAGO 14, ILL.



Boilers Built for Gas or Oil by Brownell

The drawing indicates how a Brownell Scotch Boiler can be arranged to accommodate any of a wide range of gas or oil burners.

Due to the large area of heating surface in this type of boiler, gas or oil firing is unusually efficient and economical. Furthermore, the low construction is a distinct advantage where head room is limited. These boilers are also widely used for coal hand firing.

Brownell Scotch Boilers are built in 12 sizes ranging from 10 to 180 h.p. for pressures of 15 to 150 lbs.

The subject is fully covered in Bulletin No. 8-B. *Ask for a copy.*

The Brownell Company
446 North Findlay Street Dayton 1, Ohio

NOW

SELECT GEARS AS YOU SELECT ANTI-FRICTION BEARINGS

It is no longer necessary to design, manufacture or purchase special gears to meet your requirements. Foote Bros. Standardized **Duti-Rated** gears can be confidently selected for load, horsepower and life expectancy from rating tables—as easily as you now select antifriction bearings.

Foote Bros. **Duti-Rated** gears will bring you savings of 10% to 50% in costs—reduce your engineering time and assure you quick deliveries of the gears you need.

Find out for yourself what this advanced idea in gear selection can mean to your design and production. Write for specific information on any problem you are working on and mail the coupon for Bulletin DRA containing complete selection and rating tables.

Duti-Rated

STANDARDIZED GEARS

Advanced processes used in producing **Duti-Rated** gears present a standardized product never before commercially available—by using these gears on the products you manufacture:

- costs can be lower
- life can be longer
- size can be smaller
- power can be greater
- speeds can be higher
- noise can be lower

Available from 1 hp. through 200 hp., with a wide selection of ratios and center distances. Helical gear sets (parallel shafts) and worm gears (right angle drives).

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Blvd. Chicago 9, Illinois

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 S. Western Blvd., Chicago 9, Ill.

Please send me Engineering Manual DRA on Foote Bros. **Duti-Rated** Gears.

Name ....

Company ....

Address ....

City .... State ....

New and Revised American Standards

PUNCH and DIE SETS FOR TWO-POST, PUNCH PRESS TOOLS

This design and dimensional standard covers the types and range of sizes in general demand by tool designers and used by tool makers for the mounting of punch press tool details.

The two series for which standards are set up consist of back-post regular and reverse, and round and rectangular diagonal-post sets. Although these sets are of the conventional type with pressed-in guideposts and guidepost bushings, the standardized die areas may also apply to die sets having patented mountings for the guideposts and bushings. Six tables give dimensions of: the die area, the die holder and punch holder thickness, the minimum guidepost diameter, shank diameters and lengths, guideposts, guidepost bushings, and removable punch holder shanks. Because the styles and the progressive range of sizes meet the largest volume of needs of users, they may be manufactured on a continuous production basis. Furthermore, tolerances have been established that will assure a high grade of tools which can be maintained commercially in respect of the component parts and assembly.

B5.25—1950 **$ .75**

TWIST DRILLS—STRAIGHT SHANKS and TAPER SHANKS

To bring this Standard in line with current practice tolerances have been set on the various features of drills so that the products of different manufacturers will be interchangeable in the user's plants; taper shank drills have been included; the sequence of diameters of straight shank drills has been changed to correspond to the actual sizes purchased and used in industry; and the lengths of number, letter, and fraction size drills have been changed so that all three series have corresponding lengths.

Dimensions given are for standard straight shank drills varying in diameter from 0.0135 to 2.000 in.; taper shank drills from $^{1}/_{8}$ in. to $3^{1}/_{2}$ in.; the corresponding drill lengths and flute lengths; and the tolerances on drill diameter, shank diameter, back taper, overall length and flute length. Tools are defined and illustrated.

B5.12—1950 **$ .65**

For Incorporation in the Specifications You Use

SINGLE POINT CUTTING TOOLS AND TOOL POSTS

Besides being a complete revision of the 1939 Standard on Terminology and Definitions for Single Point Tools and the 1943 Standard on Tool Shanks and Tool Posts, this 1950 Edition contains a considerable amount of new material. Specifically, it defines and illustrates the different classes of tools, the parts of those tools, and the angles at which they are used. It gives the standard dimensions for tool shanks, tool post openings, and lathe center height for solid tools and tool holders. In the new sections of the Standard single point tools are listed and classified according to their shape, construction or use; the sizes of the six styles of sintered carbide tips, which have been adopted by the carbide manufacturing industries and the commercial catalog numbers are given; also the dimensions of tips and shanks for single-point tipped tools with 0° and with a 15° side-cutting edge angle; of square-end tools; of 80° and 60° nose-angle tools; and of off-set end-cutting and side-cutting tools.

B5.22—1950 **$1.25**

20-DEGREE INVOLUTE FINE-PITCH SYSTEM

For Spur and Helical Gears

This new American Standard closely follows the 1932 Spur Gear Tooth Form Standard with a slight increase in the whole depth to allow for the greater proportional clearance necessary in fine-pitch gears. The series includes gears of 20-diametral pitch and finer having a 20-degree pressure angle. The range of pinion sizes has been extended down to 7 teeth because pinions of this size are used in many servo-mechanisms. Standard tooth proportions and formulas are included, also dimensions required when using enlarged pinions. Data are given: for enlargement of helical pinions of 20-deg normal pressure angle; to show the permissible reduction in outside diameter of gears from 20 to 200 diametral pitch; and to cover the design of spur and helical pinions having 9, 8, and 7 teeth. All symbols used are defined.

B6.7—1950 **$1.50**

To Be Published in June and July

FINE-PITCH STRAIGHT BEVEL GEARS

This new American Standard was developed to cover generated straight bevel gears: (a) of 20 diametral pitch and finer, (b) for all shaft angles, and (c) with the numbers of teeth equal to or greater than 16/16, 15/17, 14/20, 13/30 for 90-deg shaft angle. Tables give general dimensions; the tooth proportions for 1 diametral pitch; the recommended tolerances for outside diameter, crown to back, and face angle; and fine-pitch straight bevel dimensions. Sketches show the important bevel gear blank dimensions and application of tolerances of bevel gear blanks.

The Standard is identical in technical content with the AGMA Standard on Fine-Pitch Straight Bevel Gears. It follows the same general principles of the 20-deg Involute Fine-Pitch System. The tooth proportions are similar to those given in the AGMA Standard on Straight and Spiral Bevel Gears with the following modifications: Clearances are increased. Tooth thicknesses correspond to those generated by a crown gear in which the tooth thickness and space width are equal. The maximum face width is limited to three tenths of the cone distance, or $\frac{8}{p}$ in., whichever is smaller.

B6.8—1950 **$1.00**

DESIGN for FINE-PITCH WORM GEARING

As the title implies, this new Standard is intended as a design procedure. It covers worms and worm gears with axes at right angles, comprising cylindrical worms with helical threads, the worm gear being hobbed for fully conjugate tooth surfaces.

It supplies the standard proportions of worms and worm gears, values of diameter for all possible combinations of leads and lead angles within the Standard, and tooth proportions based on normal pitch for all combinations of standard axial pitches and lead angles. An extensive table gives the difference in departure from a straight side of the worm profile and the changes in pressure angle produced by cutters or grinding wheels of 2-in. and 20-in. diameters. (Values in this table are diagrammatically illustrated.) Examples of fine-pitch worm and worm gear calculations are included to assist the designer in using the standard. Sketches show (1) throated worm gear blank (for power drives) and (2) non-throated worm gear blank (for transmission of motion).

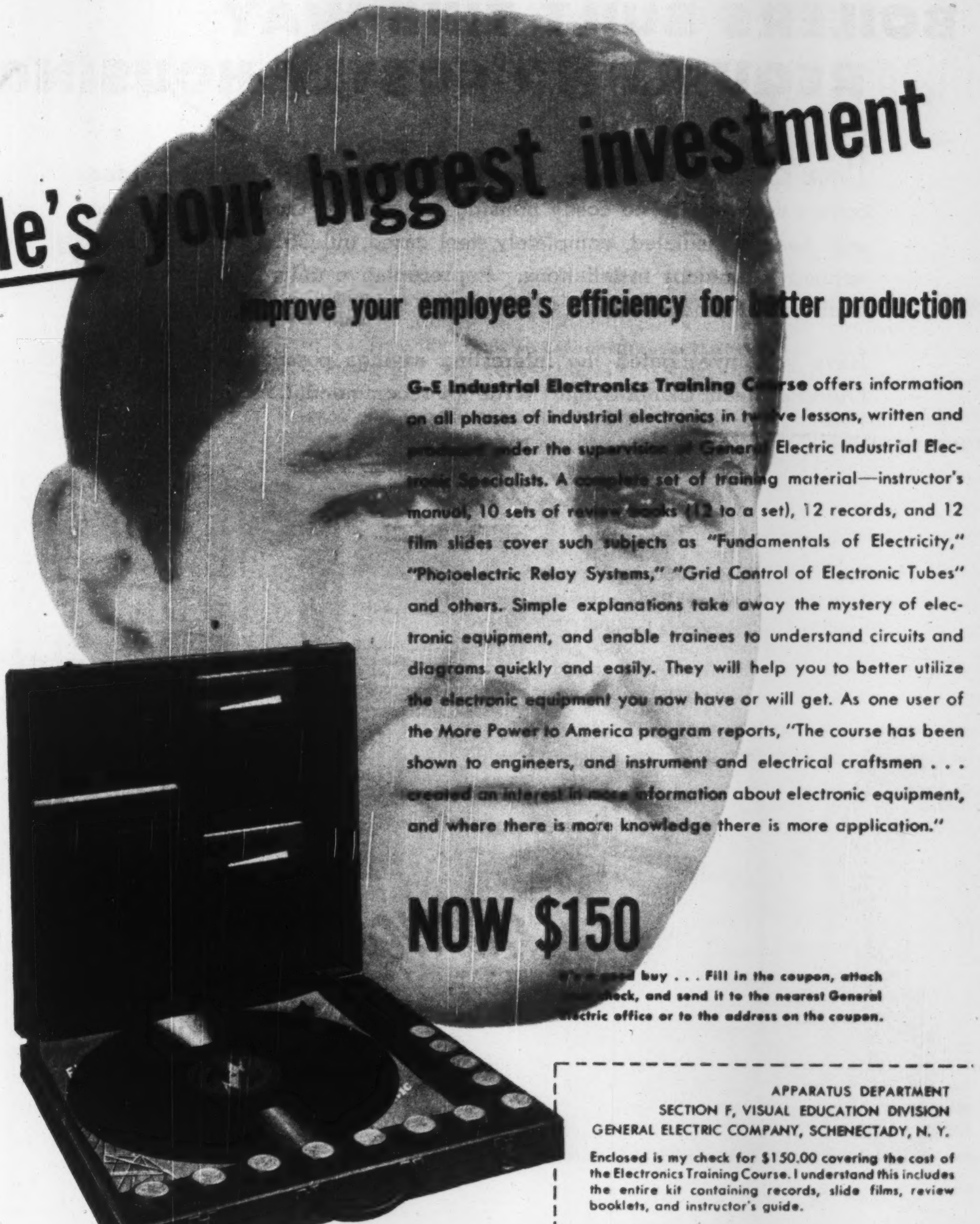
B6.9—1950 **$1.50**

20% Discount to ASME Members

The American Society of Mechanical Engineers, 29 W. 39th St., New York 18.

He's your biggest investment

Improve your employee's efficiency for better production



G-E Industrial Electronics Training Course offers information on all phases of industrial electronics in twelve lessons, written and produced under the supervision of General Electric Industrial Electronic Specialists. A complete set of training material—instructor's manual, 10 sets of review books (12 to a set), 12 records, and 12 film slides cover such subjects as "Fundamentals of Electricity," "Photoelectric Relay Systems," "Grid Control of Electronic Tubes" and others. Simple explanations take away the mystery of electronic equipment, and enable trainees to understand circuits and diagrams quickly and easily. They will help you to better utilize the electronic equipment you now have or will get. As one user of the More Power to America program reports, "The course has been shown to engineers, and instrument and electrical craftsmen . . . created an interest in more information about electronic equipment, and where there is more knowledge there is more application."

NOW $150

It's a good buy . . . Fill in the coupon, attach your check, and send it to the nearest General Electric office or to the address on the coupon.

Extra sets of review books . . $3.00 ea.

Extra instructor's manuals . . . . . $3.00 ea.

APPARATUS DEPARTMENT
SECTION F, VISUAL EDUCATION DIVISION
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Enclosed is my check for $150.00 covering the cost of the Electronics Training Course. I understand this includes the entire kit containing records, slide films, review booklets, and instructor's guide.

NAME...

COMPANY...

STREET...

CITY...STATE.................

GENERAL ELECTRIC

685-35

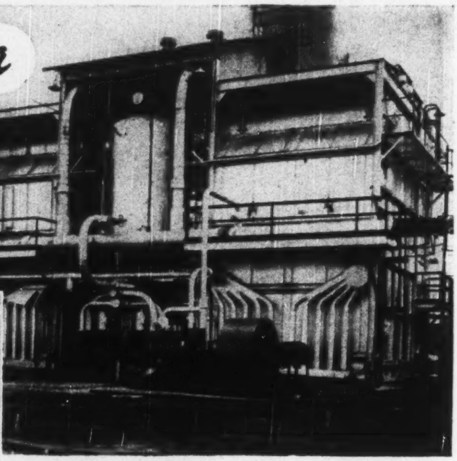
BOILERS BUILT THIS WAY REQUIRE NO COSTLY HOUSING

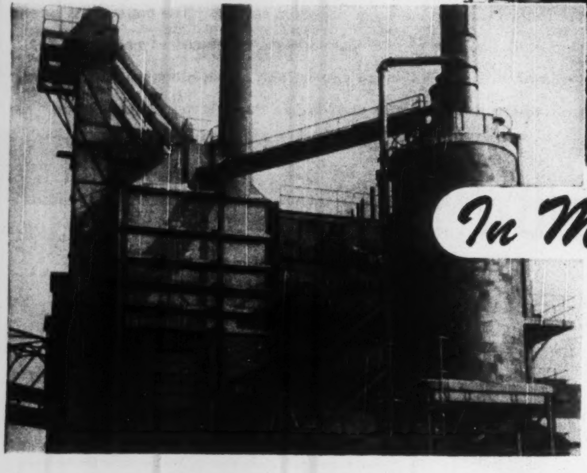
ERIE CITY has developed, manufactured and erected many **outdoor** boilers that require no costly housing structures. Our long experience with heavily insulated, completely steel cased industrial boilers is being applied to outdoor installations. Representative units in California and Michigan are shown here.

Have you investigated the interesting savings possible with Erie City Outdoor Steam Generators? Write for recommendations.

In California

2 Erie City 3-Drum 1050 h.p. 300 W.S.P. **Outdoor** Boilers, Oil or Gas fired, serving a large refinery.





In Michigan

An Erie City 3-Drum 890 h.p. 675 W.S.P. **Outdoor** Boiler, chain grate stoker fired, serving large brass goods manufacturer.

ERIE CITY

COMPLETE STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

At the Crompton & Knowles Looms Works

WORCESTER, MASS.

3 engineering department routines simplified

with Kodagraph Autopositive Paper

FILING

A low-cost, photographic intermediate paper that produced positive copies directly was "big news" for Crompton & Knowles, world's largest manufacturer of specialty looms. To begin with, it meant that they could reorganize their filing system much faster and much more economically than had been estimated. *Here was the problem:* they had some 200,000 detail drawings—4 to 8 on each sheet of paper. Many of these were not in sequence, which slowed reference; and, when blueprints of only one part were needed, it meant a waste of paper . . . besides taking the attached drawings out of the files. *Solution:* the design sheets were reproduced on Kodagraph Autopositive Paper; then the prints were cut and filed correctly in the "master" file.

* * *

DRAFTING

Crompton & Knowles has adopted the rule: "*A Kodagraph Autopositive intermediate of every drawing.*" And this is paying off today in lower re-drafting costs. *Before,* the original detail drawings (described above) and scale drawings were used as the blueprint "masters" . . . were exposed to machine wear-and-tear, constant handling. When they no longer produced legible blueprints, they had to be redrawn. *Now* the valuable originals are kept safe in the files—available for reference and revisions only. The "Autopositives" do the "heavy work" . . . whenever needed.

* * *

PRINT PRODUCTION

Using Kodagraph Autopositive intermediates, Crompton & Knowles turns out sharper, cleaner blueprints—at uniform, practical machine speeds.

That's because these new intermediates have an evenly translucent, high-quality paper base . . . and dense photographic black lines which will not smudge or lose opacity even after hundreds of trips through the machine.

How "Autopositives" are produced: Crompton & Knowles uses its blueprint machine for exposure; standard photographic solutions for processing. In this manner it gets positive copies directly —without a negative step . . . without darkroom handling.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

- **It enables you, or your local blueprinter, to produce positive photographic intermediates at a new low cost.**
- **It preserves valuable originals . . . cuts redrafting costs.**
- **It restores old, soiled drawings . . . gives you cleaner, sharper prints.**
- **It gives you photo-lasting file copies.**

A new illustrated booklet, "Modern Drawing and Document Reproduction," gives all the facts on this revolutionary photographic intermediate. It's free. Just mail the coupon.

Please mail a copy of "Modern Drawing and Document Reproduction"—your new free booklet on Kodagraph Autopositive Paper.

EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

16

Name____________________

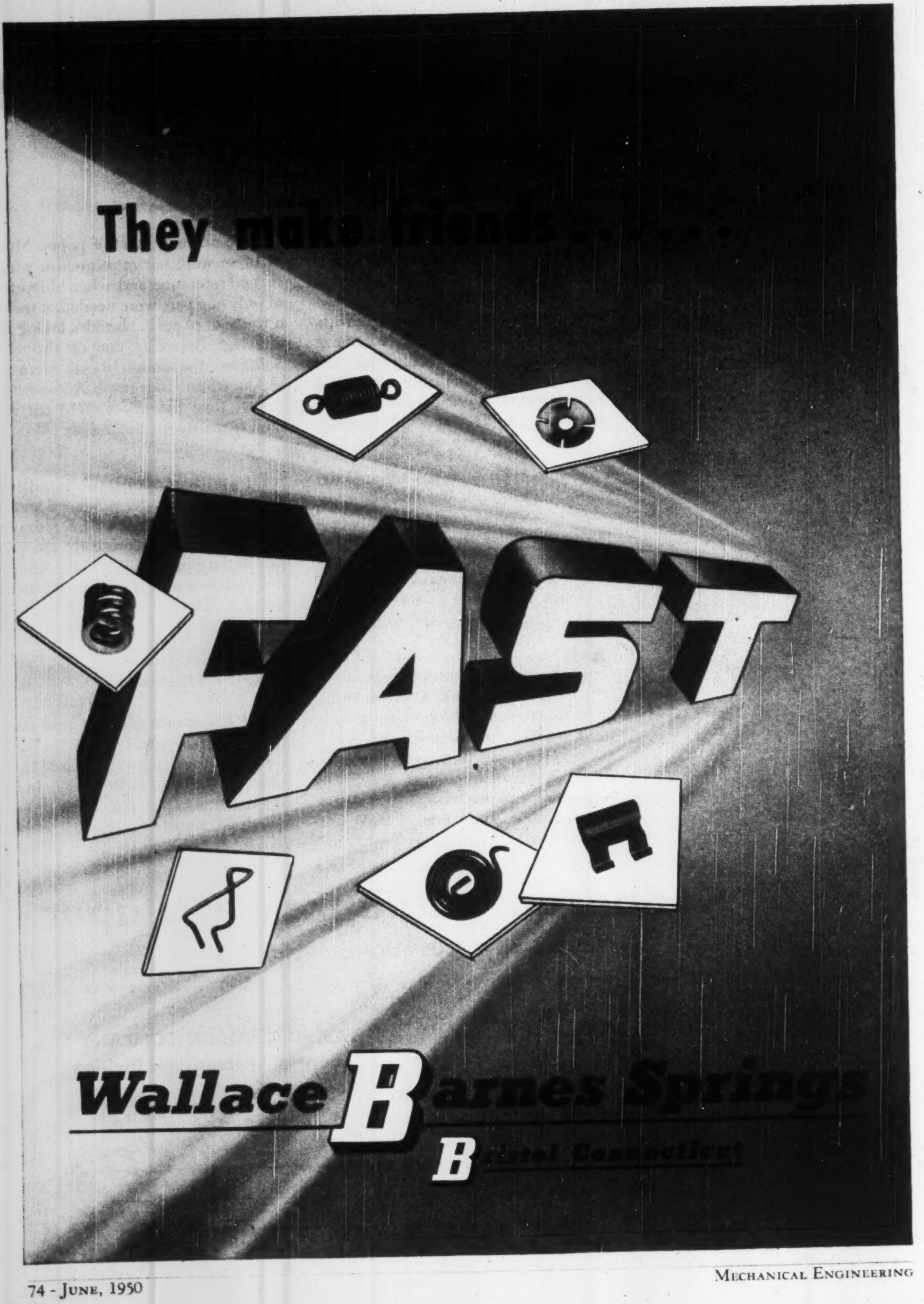
Position____________________

Company____________________

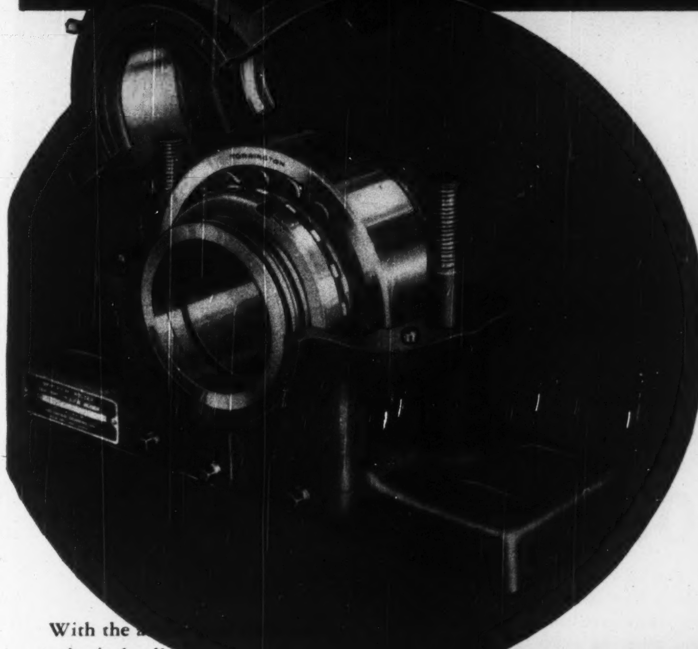
Street____________________

City__________ State__________

Kodak
TRADE-MARK


They make friends......
FAST
Wallace Barnes Springs
Bristol Connecticut

FAFNIR Spherical Roller Bearing Pillow Blocks



Two-piece split design housing

High-grade stress-relieved cast iron
Oil or grease lubrication
Held or free bearing mountings
Adaptable for oil or water cooling
Equipped with either felt seal or frictionless triple labyrinth seals
Housings with closed ends when required

Torrington Self-Aligning Spherical Roller Bearings

Completely self-aligning to compensate for any practical angular displacement of shaft. High radial and two-direction thrust capacity assure combined load-carrying ability required for heavy-duty applications.

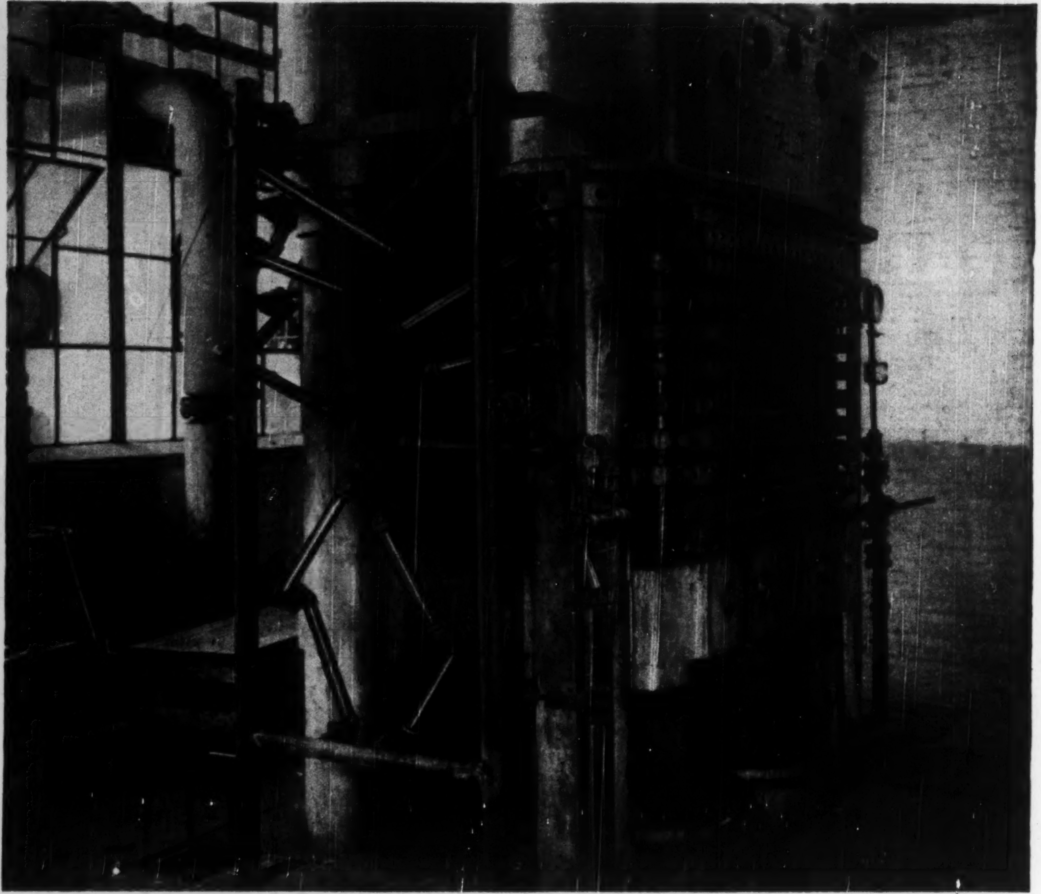
Two types — full range of sizes

Adapter type mounting for shaft diameters from $1\frac{7}{16}''$ to $7\frac{15}{16}''$.
Straight bore mounting for shaft diameters from $1\frac{15}{16}''$ to $8\frac{3}{8}''$.

With the a spherical roller blocks, Fafnir offers anti- power transmission units for every load, speed and operating condition. Incorporating the well-known Torrington spherical roller bearings, these Fafnir units combine advanced designing, rugged simplicity, ease of maintenance and long life expectancy. Write for literature. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR

BALL AND ROLLER BEARING
PILLOW BLOCKS



FLUIDS FOR MOVING PARTS ARE CARRIED BY
BARCO ROTARY SWIVEL JOINTS

Barco Joints (Rotary Swivel type) are used on this multiple press with outstanding success.

For over forty years, Barco Joints have been serving industry—each year meeting ever-changing problems with constant new development.

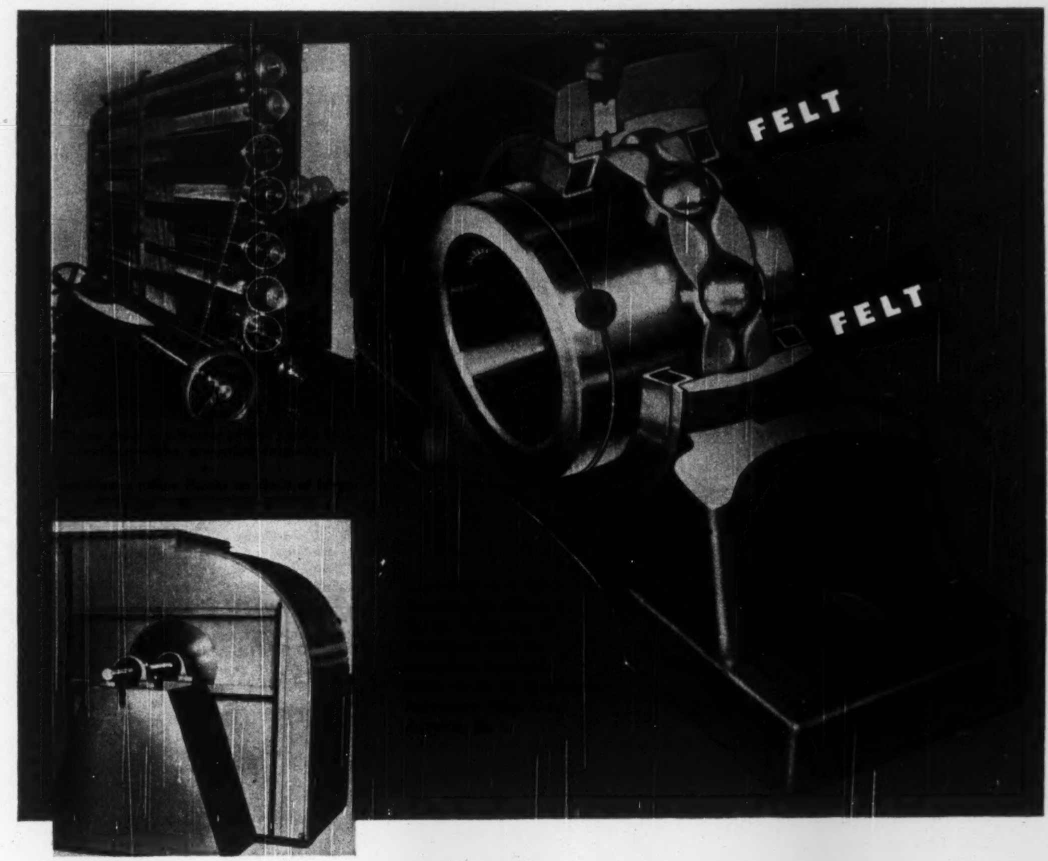
In addition, they are used in almost every kind of job requiring *flexible* fluid-conveying systems. By absorbing strain and stress, by compensating for expansion and contraction, Barco joints have proved their value in an infinite variety of applications. Write for full information to Barco Manufacturing Company, 1807G Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Canada.

BARCO FLEXIBLE JOINTS

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"



Let's LOOK INTO the Use of FELT by SEALMASTER

• Here is an exceptionally interesting example of the use of American Felt in a bearing seal. Note that the seal consists of an inner labyrinth ring pressed into the outer race of the bearing, an outer flinger ring pressed onto the inner race of the bearing, and a ring of felt in the channel between the two. The felt rotates with the outer ring, and as it is assembled without pressure, there is no danger of glazing or wear.

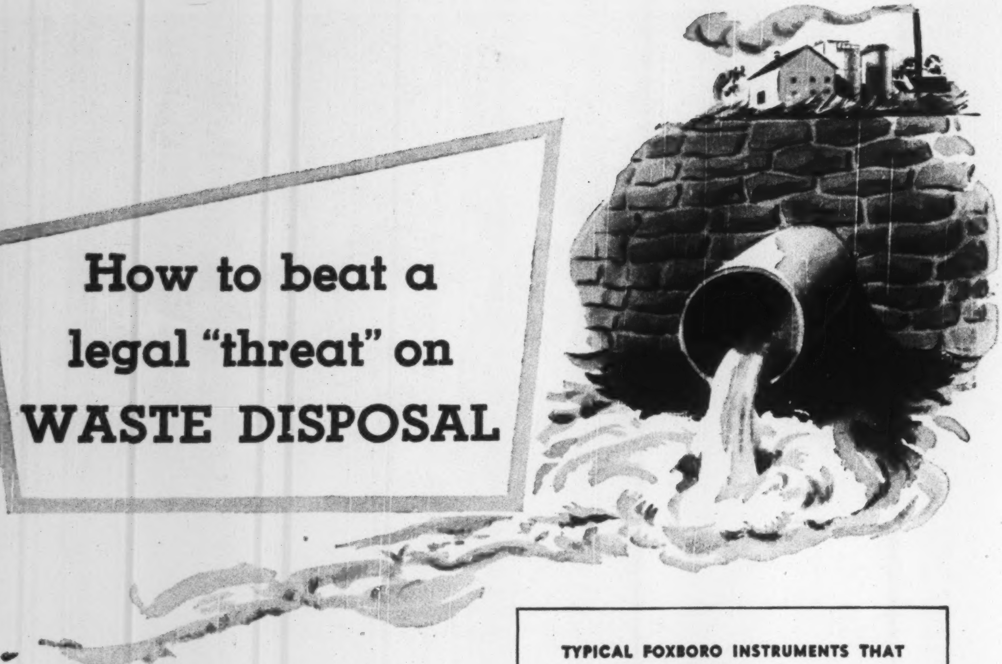
Now let's see what happens in service. Due to the rotation of the outer steel ring and the felt ring, a centrifugal action is developed. Three effects result from this action in combination with the design of the labyrinth: 1, entry of dirt into the seal is prevented; 2, excess grease that may work its way past the vortex or trap created by the steel seal ring on the outer race passes slowly through the felt; 3, the felt is kept clean and free from glazing. When rotation stops there are still the same barriers, except the centrifugal. No wonder these pillow blocks run for years with such protection!

• American provides various types of felt, plain or laminated with impervious materials, to meet the need for reliable seals. Write for authoritative Data Sheet No. 11, "Felt Seals, Their Design and Application", complete with illustrative samples.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 GLENVILLE ROAD, GLENVILLE, CONN.
ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. — SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.



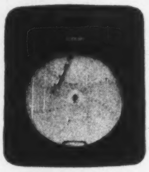
How to beat a legal "threat" on WASTE DISPOSAL

WITH STATE AFTER STATE now imposing legal restrictions on industrial waste disposal, you may be faced with this problem quite suddenly. Only by starting to gather complete data *now* can you be prepared for necessary action when that time comes.

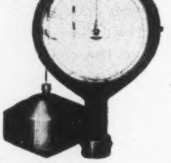
Foxboro has prepared a concise, informative bulletin on how to conduct a waste disposal survey. Based on specialized knowledge and long experience, this bulletin outlines the simple steps you can take to avoid hasty, last-minute plans. It shows how a careful, unhurried survey *now* can easily provide the facts on day-to-day quantities, concentrations, and constituents, so essential to efficient planning.

Send for a copy of "Waste Disposal Surveys", the first bulletin in Foxboro's series on Industrial Waste Disposal. Write The Foxboro Company, 182 Neponset Avenue, Foxboro, Mass., U. S. A.

TYPICAL FOXBORO INSTRUMENTS THAT LEAD TO BETTER WASTE DISPOSAL



The Model 40 . . . "The finest modern controller" . . . is the foundation of many outstanding Foxboro Waste Disposal Systems. It is used for the control of flow, pH, conductivity, temperature and other variables. Thousands are in use daily.



Foxboro Float and Cable Type Instruments are specifically designed for use on weirs and Parshall flumes. They read directly in *flow*.

FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

Continuing Metallurgical Study Produces Major Savings For Utilities

BACK some ten years ago, Kellogg's metallurgists, working with the turbine manufacturers, discovered that carbon-moly steel, which had been "killed" with less than half a pound of aluminum per ton, could readily be heat-treated at lower temperature to achieve the desired uniform acicular grain size for optimum elevated temperature strength.

This was, naturally, important as the demand grew for piping to withstand operating temperatures up to 950° F. But even more important was the later discovery that this steel showed practically no graphitization at this temperature. As a matter of fact, when graphitization troubles hit the utility industry in general during the early forties, *Kellogg* carbon-moly installations using this steel were found to be unaffected. Obviously this meant a saving of hundreds of thousands of dollars for those utility companies that had followed Kellogg carbon-moly specifications.

Today, to prevent graphitization at even higher temperatures (up to 1050° F.) chrome-moly steels have been generally adopted by the industry for main steam piping.

Functioning in the same pattern as they did a decade ago, Kellogg's metallurgical groups are currently working toward pin-pointing the *minimum amount* of chromium that can be used successfully in high temperature piping.

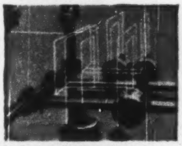
Specific and continuing development work is one of the many advantages that utility companies gain when they specify M. W. Kellogg high temperature and high pressure piping.

Illustrated — *photomicrograph (500× m.) of specimen indicating presence of graphitization.*

M. W. KELLOGG

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.



Exclusive Equipment for accurately analyzing stresses in piping and providing unique data for critical installations

Complete facilities for the fabrication of steel products from simple forgings to specially cast bi-metallic devices.

Top welding performance in shops and in the field by welders accustomed to working under X-Ray checks.

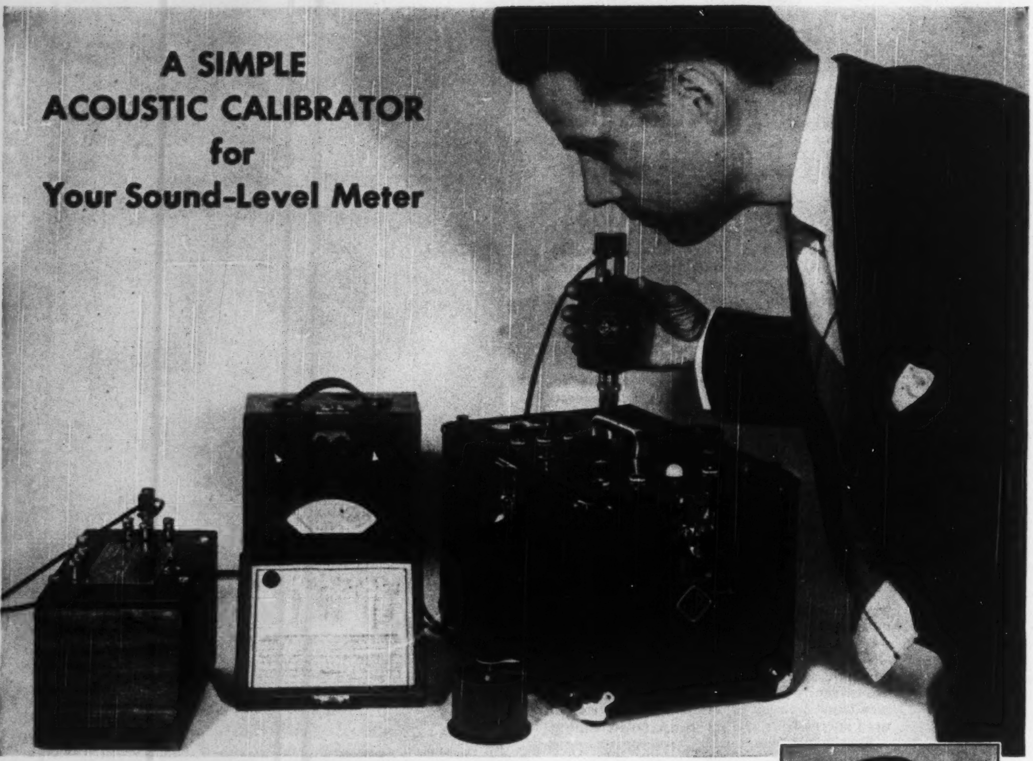
Quality control, devised by metallurgical experts, embracing forming, heat treating and non-destructive testing.

Vessels
Exchangers
Condensers
Process Piping
Forged and Welded Fittings
Radial Brick Chimneys

★

The M. W. Kellogg Company, Inc. (A Subsidiary of Pullman, Inc.) – Offices in New York, Jersey City, Buffalo, Los Angeles, Tulsa Houston, Toronto, London and Paris

A SIMPLE ACOUSTIC CALIBRATOR for Your Sound-Level Meter

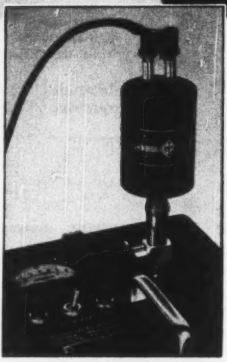


THE G-R Type 759-A and -B Sound-Level Meters have built-in calibrators for their electrical circuits; no means are readily available, however, to check the condition and calibration of their associated microphones.

The new Type 1552-A Sound-Level Calibrator is introduced as a simple, convenient and accurate method for calibrating both the microphone and the over-all system. Essentially it consists of a small, stabilized and rugged loud-speaker mounted in an enclosure which fits over the microphone in the sound-level meter. The acoustic coupling between the calibrator and the microphone is fixed and can be repeated accurately. Any audio oscillator with a harmonic content of less than 5%, supplying 2 volts at 400 cycles, can be used to operate the calibrator. A 500-ohm potentiometer is required as an output control if the oscillator is not equipped with such a control. An accurate vacuum-tube voltmeter is needed to measure the voltage across the calibrator.

The level at which the calibrator is used is such that its operation is not affected by ordinary background noises. This simple device is an ideal means not only for assuring consistency of calibration and locating defective microphones, but also for inter-standardization of several sound level meters.

The audio oscillator, v-t voltmeter and potentiometer shown in the set-up photograph are standard G-R items. If you need these or if you do not know about the complete line of G-R noise and vibration measuring and analyzing equipment. **WRITE FOR THE "NOISE PRIMER".**



The Sound-Level Calibrator was designed for use primarily with the Shure Brothers Type 9898 microphone as used on the G-R Type 759-B Sound-Level Meter. It can be used on other microphones such as the Brush BR2S Sound Cell Microphone and the Western Electric Type 633-A Dynamic Microphone.

TYPE 1552-A Sound-Level Calibrator $45.00

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

No shutdown, no slowdown and no bearings missed with Farval lubrication

WEBER bag machines produce paper bags at speeds up to 500 per minute. Machines are run continuously at high speeds up to 24 hours a day, and in all climates all over the world.

Good lubrication—vital to trouble-free operation—is provided by Farval Centralized Lubrication, which is offered as optional equipment on every machine.

According to the machine manufacturer:

"Centralized lubrication with Farval is a distinct aid to positive lubrication of hard-to-get-at places which previously required the machine to be shut down to reach the hidden bearings that were frequently missed entirely, either intentionally or due to an oversight.

"The closed bearings now used with the Farval system also practically eliminate any possible abrasive effects where undesirable conditions are encountered. Maintenance time has been cut to a minimum, since the entire machine can be lubricated while in operation. Bearing life has been increased tremendously. Oil and grease drippings have been eliminated since lubrication is clean and efficient with no waste lubricant to soil machine or paper bags."

Farval is the original (patented) Dualine system of centralized lubrication that has proven itself through years of service. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned.

Write for Bulletin 25 for full details. The Farval Corporation, 3264 East 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

FARVAL—*Studies in Centralized Lubrication*
No. 115

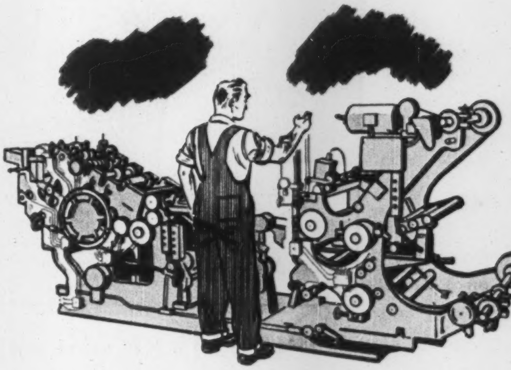
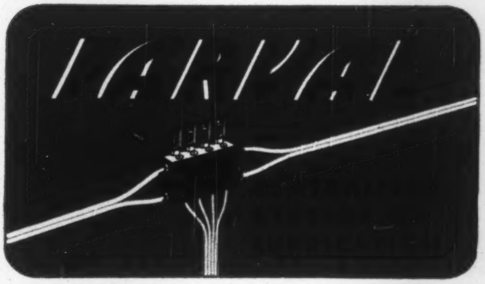
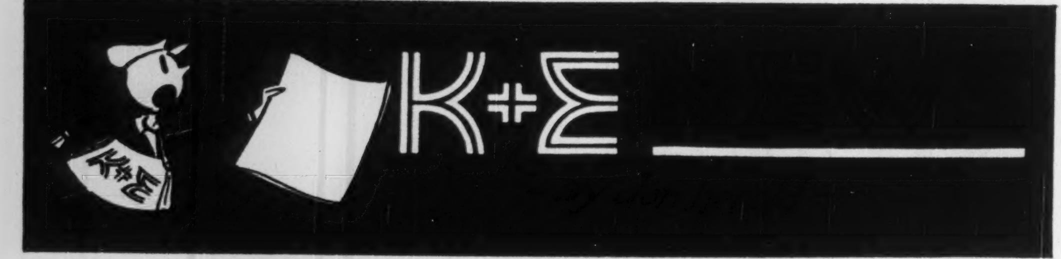


Illustration courtesy of H. G. Weber & Co., Inc., Kiel, Wis.





"POSITIVELY–it's the spittin' image"

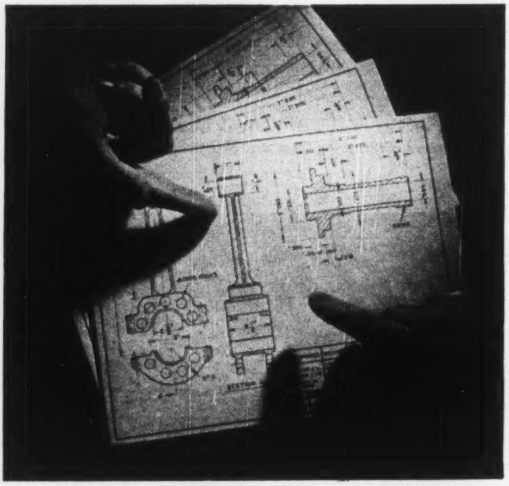
HELIOS * dry developed, positive line prints on white backgrounds are exactly like your originals. You can count on their uniformity, crispness and clearness, whether the lines are black, blue or maroon.

K&E shoot for dependability in every item of their HELIOS line. They established a special plant to produce HELIOS materials exclusively—even the image-forming chemical components. So, HELIOS papers, cloths and films are the result of 83 years of K&E thoroughness and K&E zeal for perfection.

You can have HELIOS in opaque papers and opaque cloth for working prints, besides transparent papers and cloth, and clear and matte films, for intermediate originals (to use in place of originals).

You can print and develop HELIOS reproductions easily with any dry diazo ammonia process machine—even in a small office. No water, no wet mess, no plumbing—just a few seconds of a simple vapor treatment, and the job is done.

*Trade Mark®



"PARAGON, eh.....
has it a pedigree?"

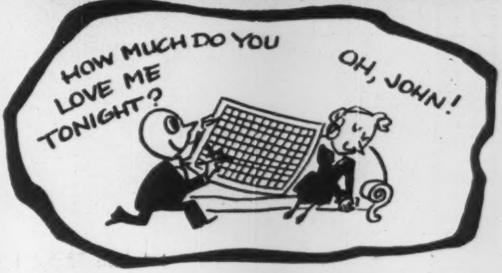
Yes, sir, there's a long pedigree to every K&E PARAGON* Surveying Instrument.

When you buy surveying instruments, you're not buying toothpicks or neckties. You're buying accuracy and endurance for a lifetime. And you're spending real money.

You want to know about the optics, the accuracy, the metals used, the wear on moving parts, the permanency of adjustment, the resistance to dust and moisture, the workmanship—and many other things.

These questions are all pretty well answered in Keuffel & Esser's 83-year-old reputation for making mighty good things for engineers and draftsmen. For 83 years, K&E equipment and materials have been partners in nearly every engineering project of any size anywhere. So, that's why I say: buy K&E PARAGON Surveying Instruments.

[redacted]


HOW MUCH DO YOU LOVE ME TONIGHT?
OH, JOHN!

What do you want to graph—Grandma's health or variations in the price of spinach—polar coordinates or the surface tension of prunes?

Send for this free book
K&E
Graph Sheets

K&E have a graph form for almost anything. Ask your K&E distributor or the factory for a catalog of their 300 forms, or if you need one they don't have, maybe they'll make up one for you, tailor-made.

They have graph sheets for plotting scientific data—square or rectangular section, logarithmic, reciprocal, electrical, and such. And forms for sketching and drawing, whether mechanical and architectural or for surveying and mapping. Also, business and financial graph forms—time series, data sheets and percentage. Their forms are on high quality tough drawing paper and on top quality tracing papers (including the famous ALBANENE*). Don't grope—graph ...on a K&E form.

*Trade Mark®

K+E
partners in creating
For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

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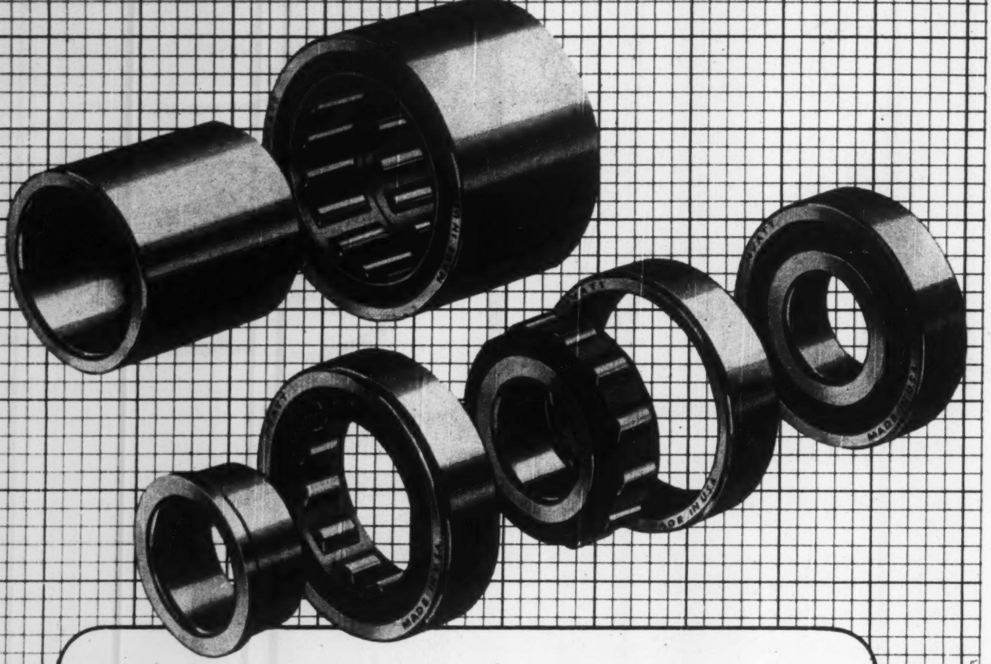


Take Advantage of HYATT Experience

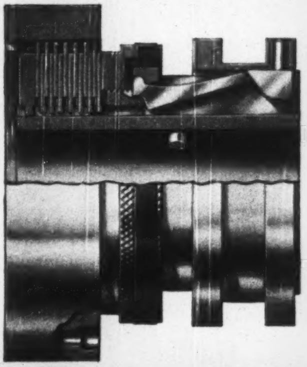
Hyatt Hy-Load bearings are high capacity cylindrical roller bearings. They are available in two diameter series, wide and narrow widths and standard AFBMA boundary dimensions.

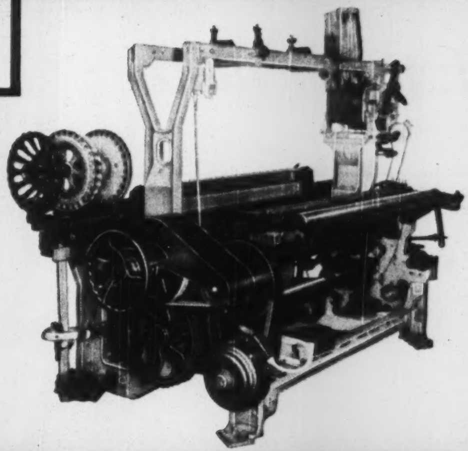
There are ten major types; four with separable inner races, two with separable outer races and four which are non-separable.

This wide range of available sizes and types, plus complete interchangeability of parts permits wide flexibility of machine design and assembly procedures.

Over the years, more and more design engineers have come to rely upon Hyatt for completely dependable bearing engineering. If bearings are part of the machine you are designing reach for your Hyatt catalog or make use of the Hyatt Engineering Service. For further information write to Hyatt Bearings Division, General Motors Corporation, Harrison, N. J., Chicago, Detroit, Pittsburgh and Oakland, Calif.

HYATT ROLLER BEARINGS





MAXITORQ

The Maxitorq floating disc Clutch is now playing a new part in aiding Textile plants to cut production costs. Introduced by the H. F. Livermore Corporation, manufacturers of improved loom parts and accessories, a "package drive" unit is available for attachment to existing looms. The unit consists of two Maxitorq Clutches, one used as a drive, the other as a brake. Single units of either are also supplied. Thus the machine may be individually driven at today's high speeds . . . for greater output.

The compact, streamlined Maxitorq is original equipment with leading manufacturers of Machine Tools, Machines for Packaging, Mining, Labeling, Lumbering . . . for Trucks, Hoists, Sweepers, Mowers, etc. Its design is of utmost simplicity yet highly efficient within its capacity to 15 H.P. @ 100 r.p.m. "Floating discs" prevent drag, abrasion and heating. Clutches are shipped ready to slip onto a shaft, yet adjustment, take-apart and assembly are manual. Special Driving Cups, if desired, also Overload Release Feature.

Send for NEW 1950 Catalog ME6

4CJ50

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

TO REACH AN IMPORTANT
"BUYERS MARKET"
EFFECTIVELY.....

Exhibit at the **19th**

NATIONAL POWER SHOW

NATIONAL EXPOSITION OF POWER
& MECHANICAL ENGINEERING

GRAND CENTRAL PALACE, N.Y.

**NOV. 27
to
DEC. 2**

If your products will help industries to cut their costs of producing and applying steam, electric, and mechanical power, a huge selective and concentrated "buyers" market awaits you at the 1950 Power Show. Thousands of executives, engineers, and operating personnel are coming to this important market-place . . . to see and learn about newest cost-saving equipment, methods, and supplies . . . to plan future purchases for much needed modernization and expansion of their plant facilities. What an opportunity to get your products on the "front counter" of today's increasingly competitive market! An exhibit at the Power Show will enable you to accomplish months of effective, economical sales work in only six days . . . to show, tell and sell under most favorable conditions. Don't miss this big sales-building opportunity. Decide now to exhibit . . . you'll be glad you did . . . as have many leading manufacturers since 1922.

Reserve Space Now...

Nearly 300 other firms already have, but a few choice locations are still available. So write today for full information.

UNDER A.S.M.E. AUSPICES
in conjunction with the Annual Meeting
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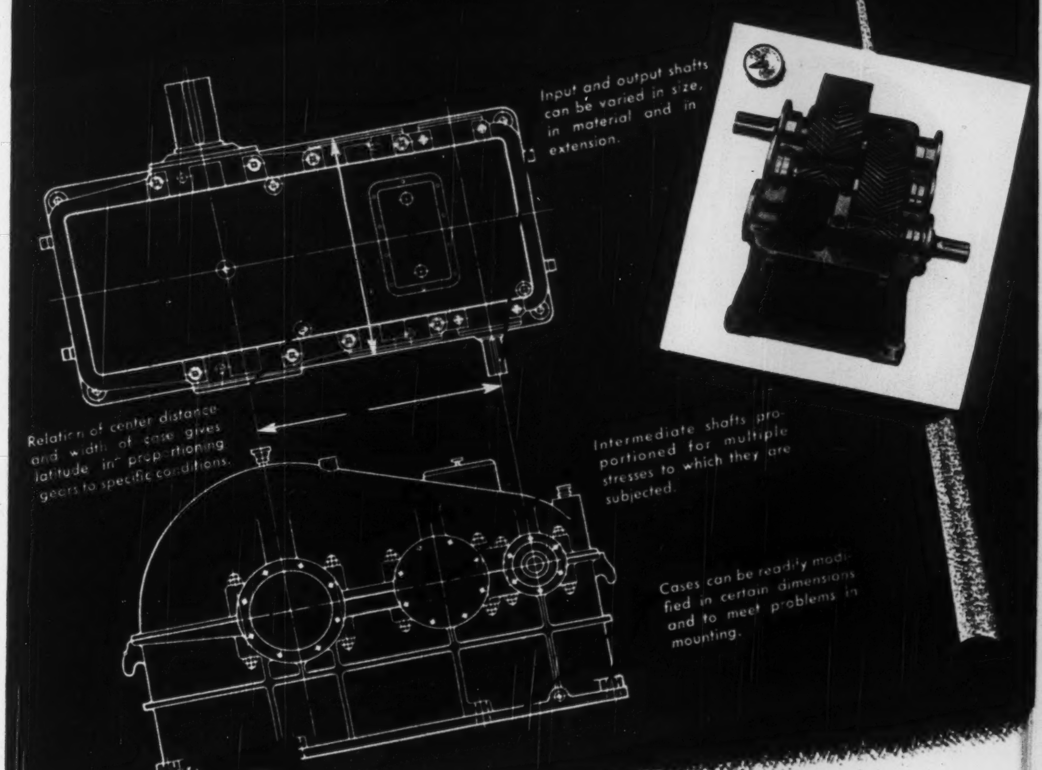
Management International Exposition Company, Grand Central Palace, New York 17, N. Y.

SPEED REDUCERS . . .


Input and output shafts can be varied in size, in material and in extension.
Relation of center distance and width of case gives latitude in proportioning gears to specific conditions.
Intermediate shafts proportioned for multiple stresses to which they are subjected.
Cases can be readily modified in certain dimensions and to meet problems in mounting.

STANDARD IN PRINCIPAL FEATURES BUT ADAPTABLE IN CRITICAL DETAIL

Farrel speed reducers have been developed for continuous, trouble-free operation under difficult service conditions. Gears, shafts and bearings are factored to safeguard against interruption of vital processes; gear cases are proportioned to withstand repeated heavy peak loads; joints are sealed to prevent entrance of dust and dirt.

But, that is not all. Without sacrificing the advantages of general standards, the design of these units permits an engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements. This flexibility allows an engineering exactness in critical detail, which has resulted in the solution of innumerable application problems.

Write for further details. Ask for a copy of Bulletin 449—no cost or obligation.

FARREL-BIRMINGHAM COMPANY, INC. • 344 VULCAN STREET, BUFFALO 7, N. Y.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Cincinnati, Detroit, Chicago, Los Angeles, Tulsa, Houston, New Orleans.

FB-592

THE GEAR WITH A BACKBONE

The gears used in Farrel speed reducers have a *backbone,* formed by the meeting of the two helices. This *backbone* provides extra strength and greater load-carrying and shock capacity — especially important in heavy duty units. Precision generation by the famous Farrel-Sykes method assures accuracy of tooth spacing, tooth contour and helix angle, which pay off in smooth, quiet, uniform operation.

Farrel-Birmingham®

are businessmen

COLD-

BLOODED?

OF COURSE NOT! Literally, their normal body temperature is 98.6—same as laborers, engineers or any other group of people. And, figuratively, they're no more, or no less, cold-blooded—as a group.

We all know unreasonable generalizations can be dangerously false. Common sense and on-the-job experience show us the value of dealing specifically with ideas, problems—and *people.*

Let's not make the big—and costly—mistake, then, of generalizing on religious or racial groups. Adopt and *carry out* these common sense principles:

1. Accept—or reject—people on *their individual worth.*
2. Don't listen to or spread rumors against a race or a religion.
3. Speak up, wherever we are, *against* prejudice. Work for understanding.

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Published in the public interest by:

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CONFIDENTIALLY . . .

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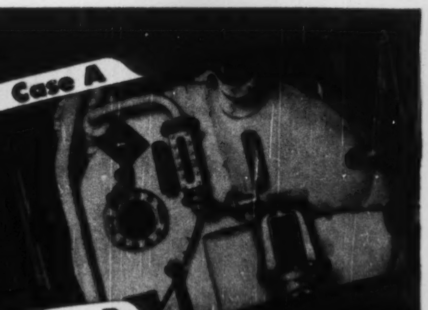

Case A

Case B

Case C

Case D

Case E

A. [illegible]

B. [illegible]

C. [illegible]

D. [illegible]

E. [illegible]

[illegible]

Manufacturing Engineers

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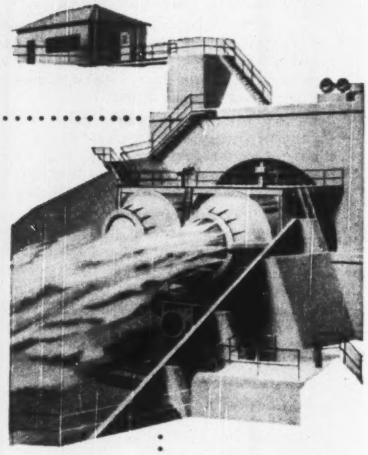
ONE OF A SERIES DEMONSTRATING APPLIED LUKENOMICS

YARDSTICK FOR A FLOOD... or how to insure years of accurate Venturi-metering in giant penstocks

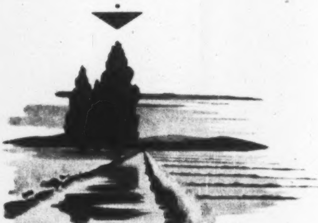


Accurate regulation of fast-flowing debris-laden water in San Gabriel Dam No. 1—world's greatest earth- and rock-filled structure—posed an important engineering problem. Four specially designed nickel-clad steel Venturi tubes were finally specified and installed. Designed for maximum discharge, these tubes have much higher throat velocities than ever before used and a differential pressure of about 22 feet of water between inlet and throat. Although tubes were of welded construction, riveted joints, with ¼" space between throats and inlets and outlets, were used in the tunnel sections to facilitate replacement, if required. Uniqueness of the installation required development of special flow measuring instruments using mercury. This Venturi design has been entirely satisfactory in over 13 years of operation giving consistent accuracy of metering with minimum maintenance.

Advances in structural design have resulted in increased efficiency . . . lower maintenance and operating costs . . . improved performance. Many improvements have been the result of close cooperation between designer, engineer, fabricator and materials supplier. We call this *Lukenomics.* Such an approach is at your disposal to help solve your cost and amortization problems along with other vital considerations.

To obtain the advantages of equipment built by fabricators applying the Lukenomics principle, write our Manager of Marketing Service, Lukens Steel Company, 402 Lukens Building, Coatesville, Pennsylvania.

San Gabriel Dam No. 1 was constructed by Los Angeles County Flood Control District. Lukens Nickel-Clad Steel was selected for Venturi tubes because of the severe corrosive and erosive action of silt- and debris-laden flood waters.



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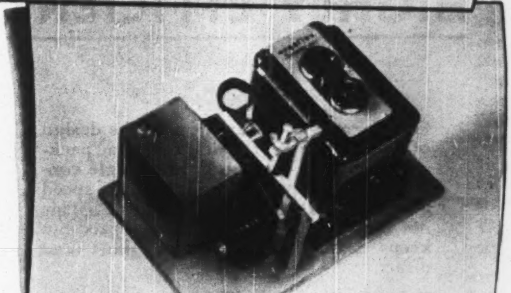
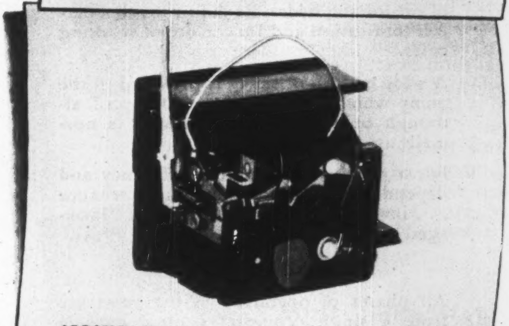
LUKENS STEEL COMPANY

BETTER PRODUCTS FOR BETTER EQUIPMENT

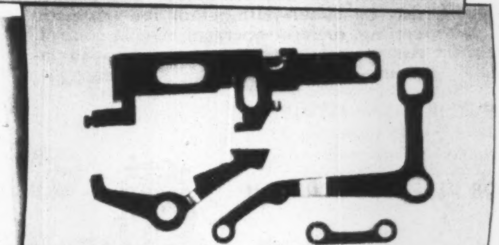
ARGOFLEX 75 CAMERA—Most popular in the Argus line.



LIFE TEST MACHINE—Automatically winds and snaps shutter. Constant tests made show shutter will click for a lifetime of picture-taking by the most ardent camera fan.



ARGOFLEX 75—With case removed to show complete shutter assembly.



THESE SHUTTER PARTS *(Actual size.)* show intricate stampings of watch-like precision made of a special stretcher straightened Revere Brass strip stock, held to plus or minus .0007 thickness tolerance.

WHY THE ARGOFLEX 75 GIVES CAMERA FANS

A Lifetime of Clicks without Kicks

Revere Brass used in shutter mechanism combines special tolerances and watch-like precision with durability and low cost

IN developing the shutter mechanism for their Argoflex 75 camera, engineers of Argus, Inc., Ann Arbor, Mich., had to cope with an unusually tough combination of problems. Production called for progressive die stamping operations, while to further complicate matters the stamped parts had to be constructed so as to incorporate the added feature of making double exposures impossible. The stock used had to be in strip form and without camber.

At the same time tolerances of 1/1000 to 2/1000 of an inch had to be maintained throughout the entire length of the strip, because the shutter parts had to function with watch-like precision. All of these requirements were necessary to maintain constant shutter speeds for consistent photographic results. In addition, the parts had to be durable, low in cost, and require only a minimum of hand finishing.

Together, Argus engineers and Revere's Technical Advisory Service worked on these complex problems. It was agreed that brass be used because of its workability and freedom from corrosion. Revere supplied a special stretcher straightened brass strip stock held to plus or minus .0007 thickness tolerance.

That this Revere brass strip more than adequately answers all the Argoflex 75 requirements for special tolerances, precision, durability and low cost, is borne out by its performance in operation. Said the Argus people: "Your (Revere's) Technical Advisory Service assisted us in solving these problems to our unlimited satisfaction."

In order to determine how the camera shutter mechanism would stand up in use, Argus has designed the machine you see at left which automatically winds and snaps the camera. These tests which are constantly being made on current production show the life of the camera to be far greater than the number of pictures the average photographic fan takes in an entire lifetime.

Perhaps Revere Brass or some other Revere Metal can be of help in developing or improving your product—cutting your production costs. Why not tell Revere about *your* metal problems? Call the Revere Sales Office nearest you today.

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IT'S New...

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HIGHLY EFFICIENT

Compactness is the key-note in the design of this new press . . . for it is indeed a "packaged" unit, incorporating in a single construction the pump, drive, valves, speed control devices, oil reservoir, etc. This not only results in saving floor space but keeps major pressure lines short and direct.

Robertson's standard of rugged construction has been maintained throughout to assure maximum serviceability. The use of oil for the hydraulic fluid provides perfect lubrication and longer life of working parts.

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All phases of operation of the press are from a single, compact control console which may be located at the most convenient point near the press. The control may be either push-button for automatic cycling, or lever operated manual control. Any press operation can be stopped *instantly.*

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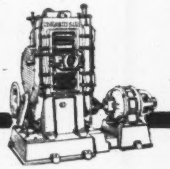

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In short, Klipfel engineers have prepared these bulletins to assist you in selecting the type and size valve best suited to your needs.

Write Dept. CM6 for any bulletins you wish. We'll gladly send them to you.

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for steam, air and water . . . in lever and weight, air loaded, pilot control and spring loaded types; descriptions, illustrations and complete selection data in Bulletin 148.

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Single and double seated types with direct action or pilot control for remote location. Types shown include quick-acting valves; all are available in angle and globe patterns. Bulletin 349.

Klipfel
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valves

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vapor pressure operated valves with spring or weight and lever loading. Valves are ball type, balanced cup and disc or balanced inner valves. Min. temp. 80°. Max. temp. 250°. Range limit of any instrument 40°.

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back pressure valves

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for control of air, steam and water pressures at the valve inlet in various types for practically any service. Bulletin 648 gives complete details including dimensions and capacities.

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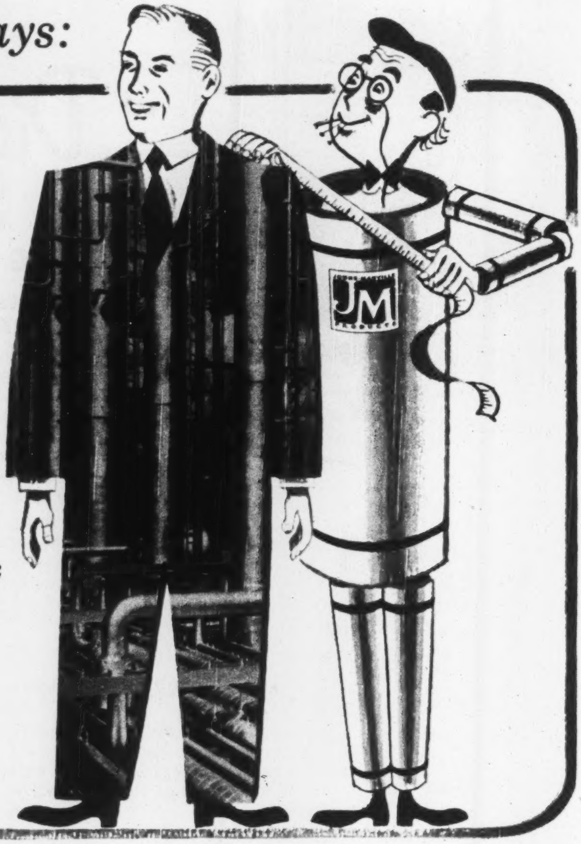
Mr. Insulation says:



"Buying insulation is like buying a suit of clothes:

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Just as no one cloth can be used for every suit of clothes, there is no one raw material that can serve as the ideal insulator for every industrial insulation job.

For this reason, Johns-Manville manufactures a wide variety of industrial insulations—of asbestos and other raw materials—each of which is designed for a special purpose. These insulations span the entire range of temperatures from 400 F below zero to 3000 F above.

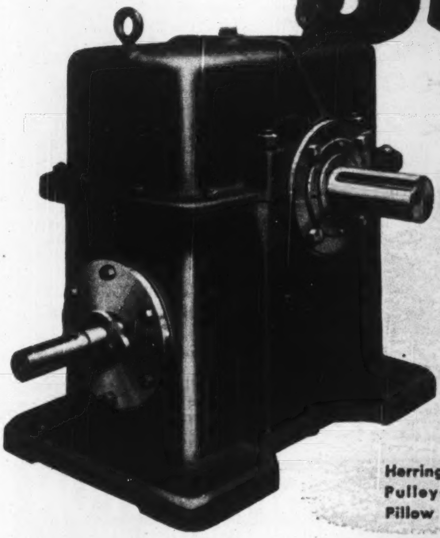
But, again, there is much more to the story of insulations than their manufacture. In order to get the greatest return from your investment in them, they must be expertly engineered to the job, and then skillfully applied.

Johns-Manville makes available to you the service of experienced insulation engineers, and highly skilled mechanics for the proper application of Johns-Manville insulations.

If you are contemplating an insulation installation for your plant, it will pay you to look into this Johns-Manville insulation service. For further information just write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *first in* **INSULATIONS**

Jones



WORM GEAR SPEED REDUCERS

A right angle unit built for heavy duty performance in any industry. The worm can be above or below the gear. Shafts are single or double extended for coupling connections or chain or gear drives.

They are built in ratios from 4 to 1 to 90 to 1 and in capacities from ¼ to 100 H.P.

Bulletin No. 68 covers selection tables and dimensions.

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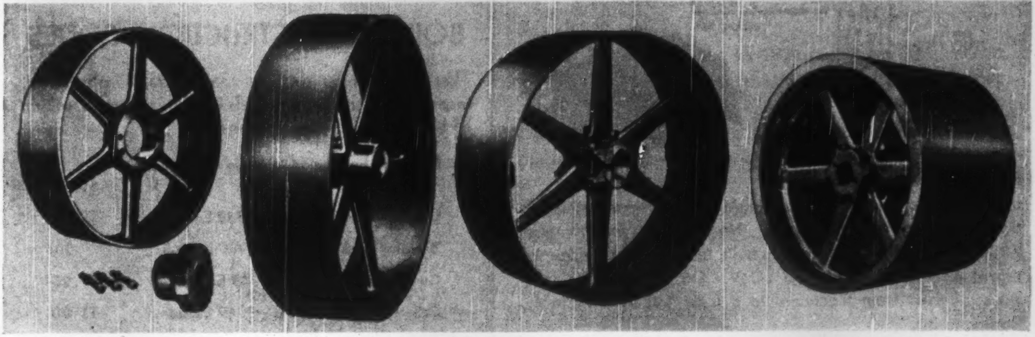
Herringbone — Worm — Spur — Gear Speed Reducers
Pulleys · Gears · V-Belt Sheaves · Anti-Friction
Pillow Blocks · Friction Clutches · Flexible Couplings

PULLEYS (CAST IRON)... ALL TYPES AND SIZES



"Sure-Grip" *Stock Pulleys.* Cast iron with crown or straight face. One-piece flanged and split tapered hub permits easy installation and removal from the shaft. 4 hubs take care of bore range from ½" to 2$\frac{7}{16}$". Available for immediate delivery in 2½" to 12" face width in 4" to 36" outside diameter. ***Standard Pulleys.*** Solid or split through rim and hub, with straight or standard crown face, accurately bored and carefully balanced. Diameters 2" to 120"—Face width from 2" to 60". ***Special Pulleys.*** Flexible pattern set-up and modern foundry facilities permit us to make ***made-to-order*** pulleys without delay. Write for detailed information.

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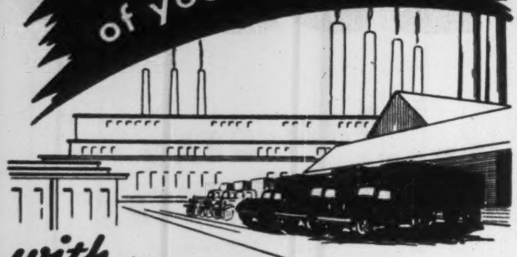
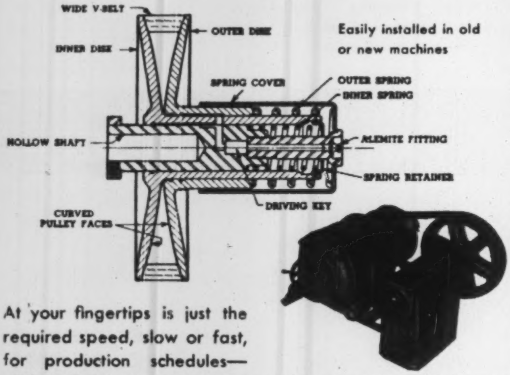


with...

LOVEJOY
VARIABLE SPEED PULLEYS



WIDE V-BELT
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SPRING COVER
OUTER SPRING
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Manufacturers: Add the strong selling appeal of Lovejoy Variable Speed Pulleys to your equipment.

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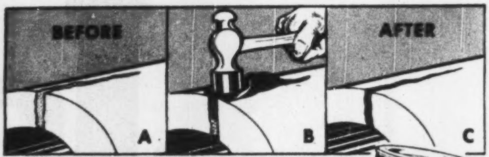

BEFORE
AFTER
A
B
C

A—Deep crack. B—Tamping Smooth-On in. C—Crack completely sealed.

STOPS LEAKS
SMOOTH-ON No. 1

If You've Never Used SMOOTH-ON, *read this:*

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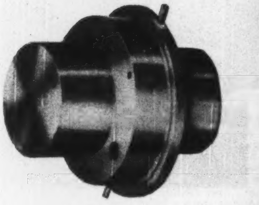

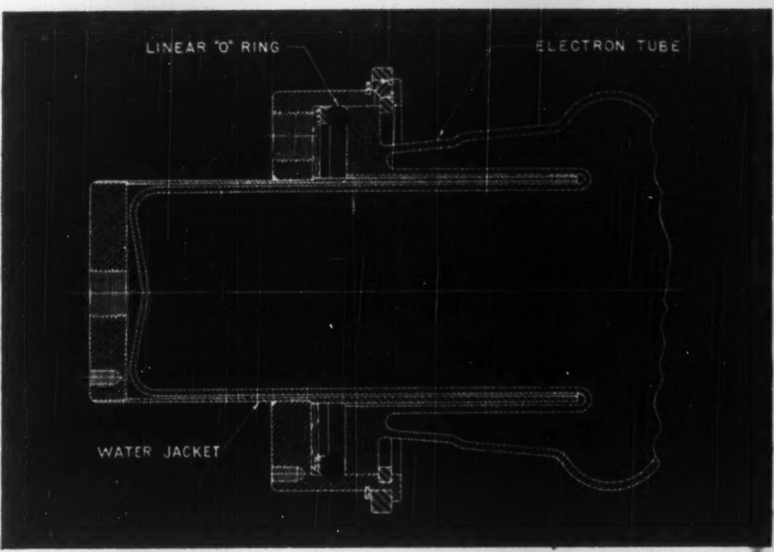

TIP...

FOR THE DESIGNER

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This required the use of a seal of many characteristics. It had to be *simple—permanent—non-adhesive to the anode wall—fool-proof*—and last but not least, *absolutely leak-proof.*

A LINEAR O-RING SEAL met these requirements. Under pressure it is leak-proof, and the seal can not be broken until the pressure is released--making it fool-proof. Requiring no replacement, it is permanent. Maintained with hand-tight pressure and no adjustment, it is non-sticking. Requiring no tools for assembly or disassembly, it is simple. That is the story of the LINEAR O-RING.

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Snaps the Trap on
• Steam Loss
• Heat Loss
• Time Loss

Strong
070-T Trap

No. 40—Product of
Steam Specialty Division
Strong, Carlisle &
Hammond Company
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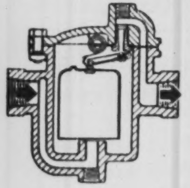
CHACE Thermostatic Bimetal helps actuate this Strong Steam Trap, designed to: (1) Automatically remove condensate without loss of steam (2) Release air and non-condensable gases to prevent air binding. Unit heaters, pressers, small kettles and other units distant from boilers and shut off nightly require the quick air and condensate removal afforded by this trap.



When cold, the bimetal coil holds bucket down and valve open for discharge of air and water; as steam reaches trap, coil expands, allowing bucket to control discharge valve. Chace No. 2100 is specified for the coil because of its high torque rate and excellent corrosion resistance. It is one of 30 bimetals which offer designers an unlimited selection of physical properties, depending on reaction desired and operating conditions to be encountered. All can be furnished in strips, coils or fabricated elements.

You can depend on the Chace Application Engineer for sound recommendations when your problem involves temperature response, indication or control. We invite you to join the well-known names who are taking advantage of our consultation service.

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Thermostatic Bimetal
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FOR POWER CONTROL DESIGNS

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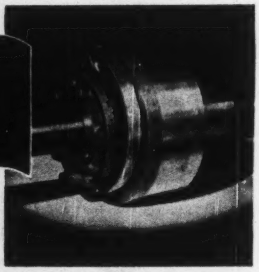
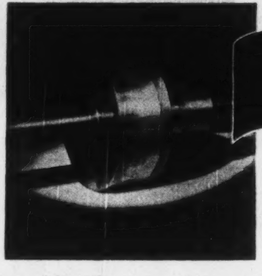
SINGLE
REVOLUTION
CLUTCH



Unequalled for accurate control of intermittent machine operations — cutting, punching, and packaging. Gives closer tolerances to cut-off, stamping, shearing, and similar machines. Completely automatic; manual, mechanical, or electrical control.



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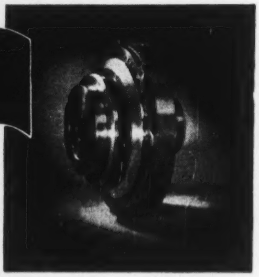
Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unexcelled for automatic two-speed drives, dual drives, stand-by drives, and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.

HILLIARD
SLIP
CLUTCH



A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations; and many other uses.

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Hilliard's Engineering Department is ready to assist you in designing installations and in selecting the correct clutch or coupling.
Write today — 3 Hilliard Clutch Bulletins with design information. Free on request.

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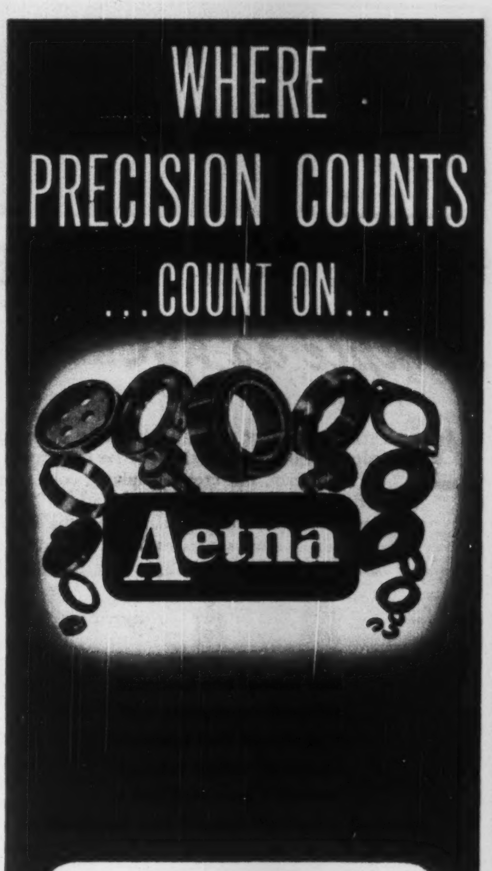

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PRECISION COUNTS
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Aetna

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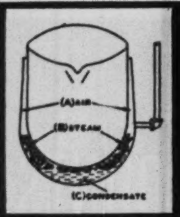

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Air and other gases in steam lines or equipment not only reduce the effective temperature of the steam, but create insulated cold spots wherever there is an accumulation. These gases are constantly generated in the boiler and air is always present when starting up. Ask for Bulletin No. 275 (Air in Steam).

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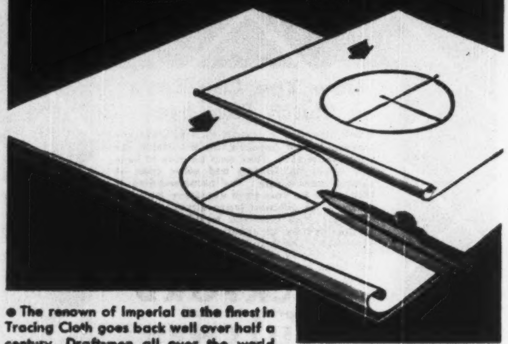

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May, 1950 CARD INDEX Vol. 72, No. 5

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
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29 West 39th St., New York 18, N. Y.

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OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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MECHANICAL DEVELOPMENT ENGINEERS

needed for employment with large eastern industrial concern. Must be graduate engineer. Work involves research, development and design of automatic, special purpose, and experimental machines. Also the analysis of alternate designs, and origination of new designs for machines currently in use. Prefer applicant with three or more years' experience in machine design engineering. Replies should include age, education, experience, salary requirement.

Address CA-3223, care of "Mechanical Engineering."

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***Write to:* Mechanical Engineer, Pennsylvania Power & Light Company, Allentown, Pennsylvania.**

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For product design on electro-mechanical and pneumatic devices for process control. Must have four years of technical schooling or equivalent and two to four years' experience in small mechanisms of the above nature, industrial instruments preferred. Should have at least 8 years' drafting experience and be familiar with modern materials, methods and manufacturing practices. Furnish particulars, age, experience and salary requirements to Personnel Department.

Minneapolis-Honeywell Regulator Company
Brown Instruments Division, Wayne & Roberts Avenue, Philadelphia 44, Penna.

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.25 a line. $1.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $20 per inch per insertion. Maximum size: 1 column, 10 inches deep; 2 columns, 5 inches deep. Copy must reach us not later than the 10th of the month preceding date of publication.

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One for design and development of Stationary Power Boilers; one experienced in rating and design of Heat Transfer Equipment. Give details of experience, education, salary expected, and personal data.

Address CA-3221, care of "Mechanical Engineering."

POWER PLANT SUPERINTENDENT

for a large industrial plant in Maryland. Applicant must be under 40 years of age, possess the degree of B.S. in M.E. from an accredited college, and have had at least 10 years' experience in the various phases of power plant operation and maintenance. He must be familiar with powdered coal and stoker-fired boilers, and steam turbine and switchboard operation. Refrigeration plant experience is also desirable. Salary open.

The Power Plant which he will superintend has an approximate steaming capacity of 500,000 pounds per hour. About half of this capacity is utilized for electrical current generation and the rest, including by-product steam from the turbine is utilized for process requirements.

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If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have — use a classified advertisement in MECHANICAL ENGINEERING for quick results.

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Experienced ENGINEER, familiar with Oil Refinery design and capable of estimating process equipment from flow diagrams.

Give full information, experience record and salary expected.

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VALVE DESIGNER—For steadily growing Chicago area company. Prefer man with design experience in the steel valve field. This is a board position. Salary commensurate with ability and experience. Address CA-3104, care of "Mechanical Engineering."

ASSISTANT TO CHIEF ENGINEER—Excellent opportunity with a progressive company in the Chicago area, for a mechanical engineer experienced in valve design. Send details of qualifications. Address CA-3105, care of "Mechanical Engineering."

MECHANICAL ENGINEERS—College teachers—Automotive, Mechanics, Thermo, others. All ranks to Dept. Heads, $8000. Give Phone, Photo, Qualifications. Cline Teachers Agency, East Lansing, Mich.

YOUNG MECHANICAL ENGINEER—Recent graduate wanted without experience but with definite ability in developing production tooling and eventually traveling in technical sales. Location Middle West. Address CA-3219, care of "Mechanical Engineering."

ENGINEER—25 to 40—capable of assuming executive responsibilities with small progressive organization having a world wide reputation. Position requires background in mechanical design and production control—will also involve sales work. Individual must have versatility and adaptability. Experience in paper converting machinery and printing press field desirable but not essential. Submit complete resumé and snapshot. Our employees know of this ad. Address CA-3220, care of "Mechanical Engineering."

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SALES REPRESENTATIVES—Soundly established, progressive firm has openings for three district sales representatives. Experience in pipe, valves or fittings an asset. Excellent opportunity. Write stating complete, detailed background. All communications confidential. Address CA-3230, care of "Mechanical Engineering."

SUPERVISOR—for statistical quality control. Knowledge of control chart techniques, sampling methods, inspection of materials and products. Experienced. Location, eastern Pennsylvania. Atlas Powder Company, Industrial Relations Dept., Wilmington 99, Delaware.

VALVE AND INSTRUMENT APPLICATION DESIGN ENGINEER—This is a combination sales and design position. Successful applicant should be an engineering graduate with a special spark for process and power valving and instrumentation. Should have ten years' experience in this field. A substantial old midwestern manufacturer offers a fine future for a man having real talent. Salary $6500 with bonus for outstanding performance. Address CA-3231, care of "Mechanical Engineering."

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PRACTICAL MECHANICAL ENGINEER—Age 36, married, registered Professional Engineer, member A.S.M.E., B.S.M.E. Carnegie Institute of Technology; ten years' shop experience, six years' machine tool design, four years' development special machinery and equipment. Not a specialist, but a capable all-around mechanical engineer who seeks a permanent connection. Address CA-3214, Care of "Mechanical Engineering."

MECHANICAL ENGINEERING GRADUATE—June '49. Top 10% of class. Vet, single, Sigma Tau. Desires trainee or junior engineering position in production, design, or development. Location immaterial, will travel. Address CA-3216, care of "Mechanical Engineering."

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Continued from Page 101

EXECUTIVE ASSISTANT—29, experienced in Industrial Engineering, production, compilation and evaluation of operating costs, report writing. Ability and personality to direct work of others. Employed. Mechanical Engineering degree. Additional education in business administration. Must locate in Southern Florida because of wife's health. Address CA-3215, care of "Mechanical Engineering."

ENGINEER—36, M.S. in M.E. 15 years' experience, 8 in engineering supervision and administration. Present position—chief engineer for chemical manufacturer. Experience includes responsible work in design, construction, maintenance and power. Seeking responsible position with progressive company. Address CA-3217, care of "Mechanical Engineering."

SALES ENGINEER—29, married, M.E. Now employed sales manager small manufacturer. Would like to manage district sales office with opportunity for development. Prefer medium or large company. Willing to relocate in East or Midwest. Address CA-3225, care of "Mechanical Engineering."

MECHANICAL ENGINEER—A.B., B.S. in M.E., Carnegie Institute of Technology, June 1950. Age 24, married, 8 months drafting experience. Desires development or design work with small progressive company. Address CA-3226, care of "Mechanical Engineering."

POWER ENGINEER—Twenty-five years' experience, operation and maintenance of modern power plants, electrical equipment, refrigeration, air conditioning and water filtration plants. Fifteen years' high pressure plant, some construcion experience, desires supervisory-engineer position with a utility, industrial plant or municipality. Registered engineer, gold seal licensed power plant operator. Will relocate or travel. Address CA-3227, care of "Mechanical Engineering."

MECHANICAL ENGINEER, B.S., M.E., A.S.M.E., A.S.H.&V.E. Age 33, family, formerly Lt. Commander. Factory training in Air Conditioning, Pumps and Steam specialties. Desires position sales representative or industrial Engineer in Seattle area. Now employed in Northwest. Address CA-3228, care of "Mechanical Engineering."

GRADUATE MECHANICAL ENGINEER—M.E. Cornell Univ., Member A.S.M.E., family, excellent educational and experience background. 13 years' successful mechanical engineering experience in research, development, design, and testing relating to both process and product activity in the electromechanical, structural, machine design, and chemical fields. Able, experienced liaison, supervision, travel, report writing. Desires permanent, responsible position with progressive organization where integrity, varied experience, and creative ability will be valued assets. Northeast preferred. Resumé on request. Address CA-3229, care of "Mechanical Engineering."

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PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member A.S.M.E. and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

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TITUS STATION

METROPOLITAN EDISON COMPANY

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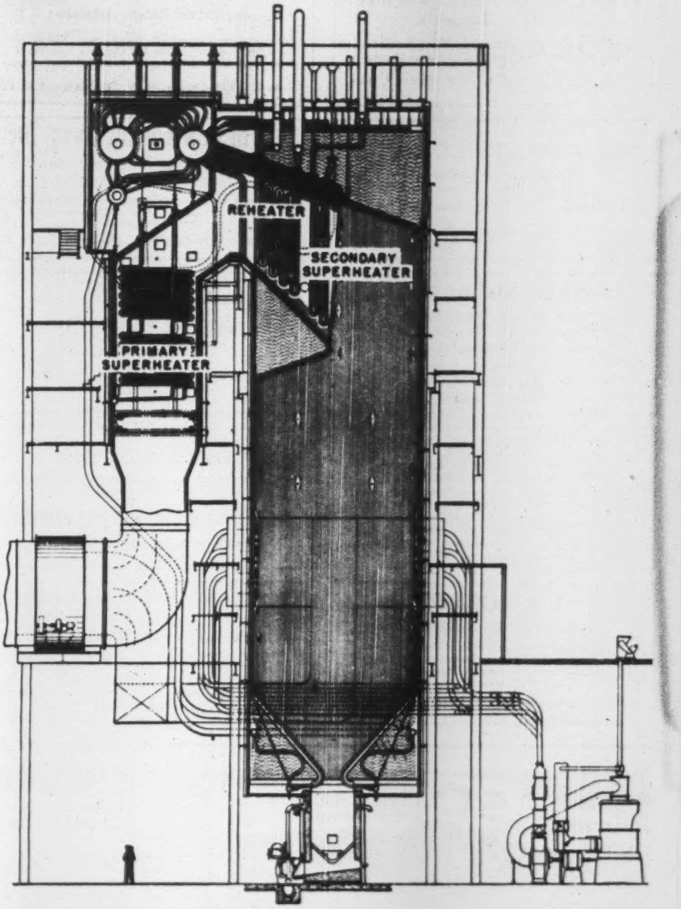
The units are of the radiant type with a reheater section located between the primary and secondary superheater surface. A finned tube economizer is located below the rear superheater section, and regenerative air heaters follow the economizer surface.

The furnaces are fully water cooled, using closely spaced plain tubes throughout. They are of the basket-bottom type, discharging to sluicing ash hoppers.

Pulverized coal firing is employed, using bowl mills and vertically-adjustable, tangential burners. Arrangements are provided for the use of oil as an alternate fuel when and if required.

B-403



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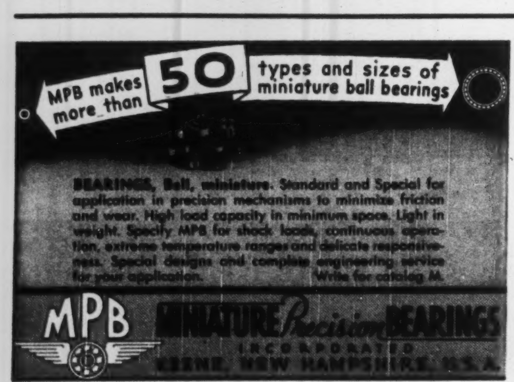

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Keeping the telephone tool kit abreast of improvements is a continuing job for Bell Telephone Laboratories. It's another example of how the Laboratories help keep the value of your telephone service high, the cost low.

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WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE BIG IN VALUE AND LOW IN COST

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Aurora Pump Co.
Automotive & Aircraft Div., American Chain & Cable

*Bailey Meter Co.
Biddle, James G., Co.
Brush Development Co.
*Buffalo Forge Co.
Bundy Tubing Co.

Cassell, John R., Co.
*Chicago Metal Hose Corp.
Chiksan Co.
Clarage Fan Co.
Cleveland Worm & Gear Co.
*Cochrane Corp.
Cone-Drive Gears Div., Michigan Tool Co.
Consolidated Engineering Corp.
*Crane Packing Co.
Cumberland Steel Co.
Cuno Engineering Corp.

DuMont, Allen B., Labs.

Eagle Pencil Co.
Economy Pumps (Inc.) Div. Hamilton-Thomas Corp.
Ellison Draft Gage Co.

Faber, Eberhard, Pencil Co.
Fenwal (Inc.)
*Foster Engineering Co.

*Garlock Packing Co.
*Gibson, Wm. D., Co., Div. Assoc. Spring Corp
*Gifford-Wood Co.

Haering, D. W. & Co.
*Hamilton Mfg. Co.
Howell Electric Motors Co.
Hydropress (Inc.)

*James, D. O., Gear Mfg. Co.

Kay Electric Co.
*Koppers Co., Fast's Coupling Dept.
Kunkle Valve Co.

Ledeen Mfg. Co.
Lefax
*Liquidometer Corp.

MB Mfg. Co.
Macmillan Co.
*Marlin-Rockwell Corp.
*Mears-Kane-Ofeldt (Inc.)
Mercoid Corp.
Morse Chain Co.

New Hampshire Ball Bearings
*Newport News Shipbuilding & Dry Dock Co.
Nice Ball Bearing Co.
Northern Blower Co.

*Oilgear Co.
O'Neil-Irwin Mfg. Co.

Pacific Pumps (Inc.)
*Pangborn Corp
Panoramic Radio Products (Inc.)
Petro-Chem Development Co.
Philosophical Library
Physicists Research Co.
Posey Iron Works (Inc.)
*Prat-Daniel Corp.

*R-S Products Corp.
Rhoads, J. E. & Sons
Rivett Lathe & Grinder (Inc.)
Robbins & Myers, Motor Div.

U. S. Electrical Motors (Inc.)
United Screw & Bolt Corp.

Vickers (Inc.)
*Vogt, Henry, Machine Co.

Waterman Engineering Co.
*Wickes Boiler Co., Div. of Wickes Corp.
*Wing, L. J., Mfg. Co.

*Zurn, J. A., Mfg. Co.

MECHANICAL ENGINEERING, 29 W. 39th S., New York 18, N. Y.

Additional information is requested on the following advertisements in the June 1950 issue.

Page No. ***Name of Advertiser***

______ ______________________________
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Name______________________ **Title**__________
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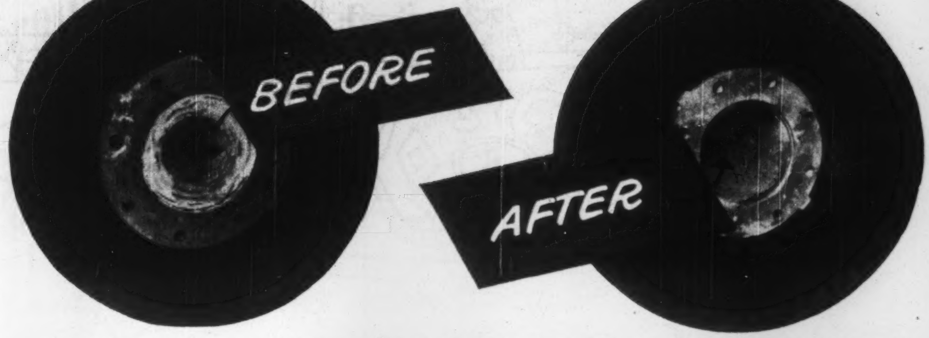
Reader Service Coupon For More Information

Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS



800 FEET OF BURIED WATER LINE CLEANED IN 8 HOURS BY DOWELL CHEMICAL SCALE REMOVAL SERVICE

Dowell Service may save you important dollars by cutting out-of-service time in maintenance cleaning to a minimum. Special chemical solvents, introduced into water lines through regular valve openings, are designed to dissolve and disentegrate scale and sludge deposits *without dismantling* the line! For example, Dowell engineers were recently called in to clean 800 feet of 4" buried water line heavily scaled with three quarters to one inch of calcium carbonate. *Within eight hours, the water line was back in use with its volume increased from 45 g.p.m. at 32 lbs. to 125 g.p.m. at 24 lbs.!*

Underground or above, indoors or out, if you have a water or product line cleaning problem, call Dowell. Leading utilities, railroads and other industries have found the Dowell Service method practical, reliable and economical. Thoroughly trained Dowell engineers do the entire job, bringing all necessary chemicals and equipment to your plant in special tank trucks.

Call your nearest Dowell office today and find out about rapid, convenient, economical Dowell Chemical Scale Removal Service for heat exchange equipment, boilers, condensers, water-lines—and for increasing water well output. Free cost estimates are gladly given.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

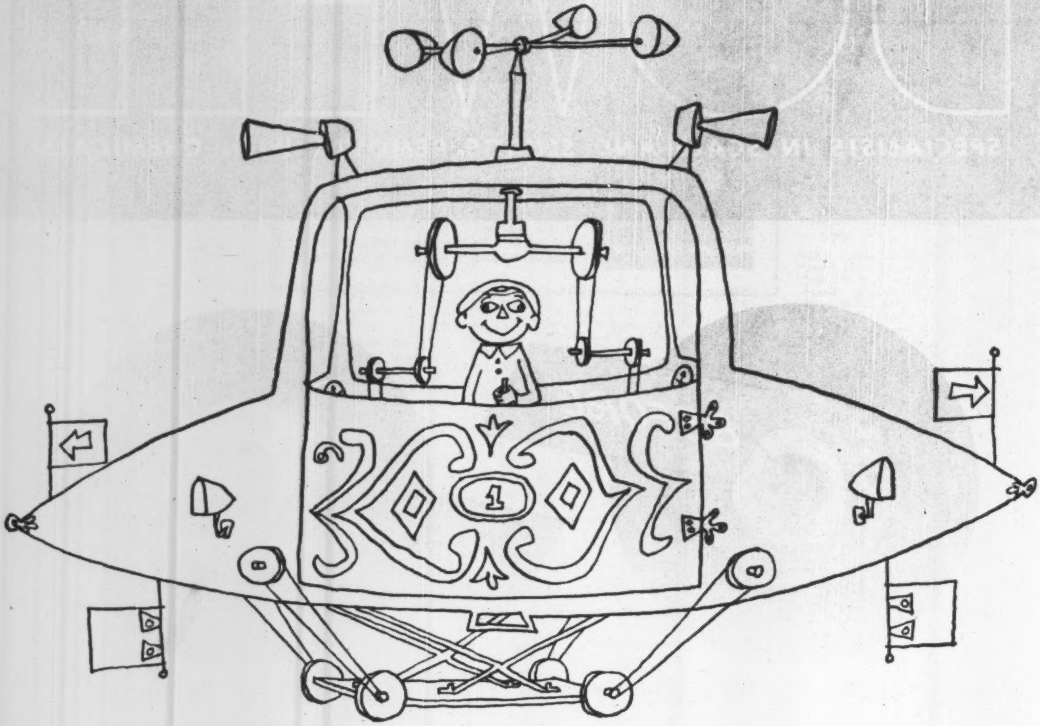
SUBSIDIARY OF THE DOW CHEMICAL COMPANY

CALL

New York 20
Boston 16
Philadelphia 2
Baltimore 18
Wilmington 99
Richmond 19
Jacksonville
Atlanta
Buffalo 2
Cleveland 13
Pittsburgh 19
Detroit 2
Chicago 2
St. Louis 8
Indianapolis
Louisville
Kansas City 8
Wichita 2
Oklahoma City 2
Houston 2
New Orleans 12
Ft. Worth 2
Shreveport 23
Anniston, Alabama
Mt. Pleasant, Mich.
Hamilton, Ohio
Charleston 27, W. Va.
Salem, Illinois
Borger, Texas
Midland, Texas
Wichita Falls, Texas
Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate-International Cementers, Inc.

DOWELL



Will it run?

Of course. The inventors are unanimous. Which way? W-e-l-l. *That* they *can't* agree on.

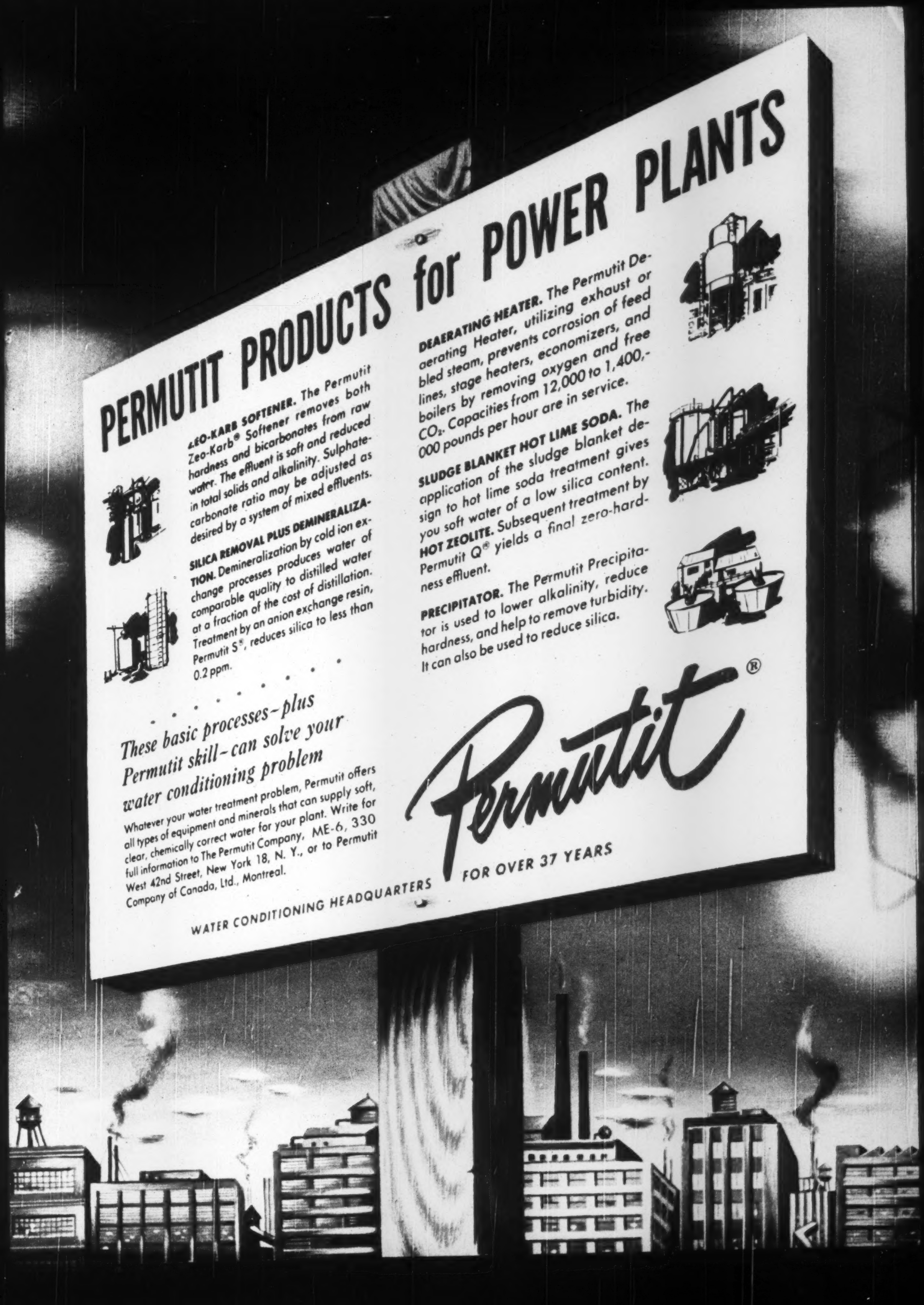
Just the same, this invention has its uses. For instance, it's a perfect example of the dangers of divided responsibility.

It's the sort of thing you avoid when you specify Carrier all the way for air conditioning, refrigeration or industrial heating. Only when the installation is completely Carrier can you be completely sure.

That's our advice. Take it and nobody will ever say about one of your projects . . . "Will it run?"

The best recipe for years of satisfaction is Carrier. Carrier founded air conditioning. Every significant advance in air conditioning from its birth has come from Carrier. These are a few of the many Carrier products all of which will fit your needs best: Conduit and Duct-type Weathermaster Systems for the multi-room building; Evaporative Condensers; Central Air Conditioners; Dehumidifiers; Self-contained Air Conditioners; Reciprocating, Centrifugal and Absorption Refrigeration Machines; Cold Diffusers and Heat Diffusers. Carrier Corporation, Syracuse, New York.

Carrier AIR CONDITIONING · REFRIGERATION · INDUSTRIAL HEATING



PERMUTIT PRODUCTS for POWER PLANTS

ZEO-KARB SOFTENER. The Permutit Zeo-Karb® Softener removes both hardness and bicarbonates from raw water. The effluent is soft and reduced in total solids and alkalinity. Sulphate-carbonate ratio may be adjusted as desired by a system of mixed effluents.

SILICA REMOVAL PLUS DEMINERALIZATION. Demineralization by cold ion exchange processes produces water of comparable quality to distilled water at a fraction of the cost of distillation. Treatment by an anion exchange resin, Permutit S®, reduces silica to less than 0.2 ppm.

DEAERATING HEATER. The Permutit Deaerating Heater, utilizing exhaust or bled steam, prevents corrosion of feed lines, stage heaters, economizers, and boilers by removing oxygen and free CO_2. Capacities from 12,000 to 1,400,000 pounds per hour are in service.

SLUDGE BLANKET HOT LIME SODA. The application of the sludge blanket design to hot lime soda treatment gives you soft water of a low silica content. **HOT ZEOLITE.** Subsequent treatment by Permutit Q® yields a final zero-hardness effluent.

PRECIPITATOR. The Permutit Precipitator is used to lower alkalinity, reduce hardness, and help to remove turbidity. It can also be used to reduce silica.

. . . .

These basic processes–plus Permutit skill–can solve your water conditioning problem

Whatever your water treatment problem, Permutit offers all types of equipment and minerals that can supply soft, clear, chemically correct water for your plant. Write for full information to The Permutit Company, ME-6, 330 West 42nd Street, New York 18, N. Y., or to Permutit Company of Canada, Ltd., Montreal.

Permutit®

WATER CONDITIONING HEADQUARTERS FOR OVER 37 YEARS

New TIMKEN® "00" bearing has maximum run-out of only 75 millionths of an inch!

Twice as accurate as the most accurate TIMKEN® bearing previously made!

WHEREVER high precision is a factor, the new Timken "Double-Zero" bearing opens the way for new standards of performance. The amazingly low run-out of these new bearings . . . only 75 millionths of an inch . . . makes possible closer machining tolerances in machine tools—accuracy to limits far beyond anything achieved before!

Already many manufacturers are using Timken "00" bearings to increase precision in their grinding machine spindles, small precision rolling mills, gear cutters, lathe spindles, dividing heads and other precision equipment.

The new Timken "Double-Zero" bearing is twice as accurate as the Timken "Zero"—previously the most accurate Timken bearing made. To make this new precision possible, Timken has developed measuring devices of extreme accuracy, built specialized machine tools and perfected new manufacturing processes. The steel used for the bearings is made in Timken's own mill, providing the correct combination of qualities for super-precision manufacture.

As a final step in production, to assure positive roll alignment, long-lasting precision, permanent adjustment and smoother operation, every Timken "Double-Zero" bearing goes through an extra process. A natural and true geometric contact is generated between all rotating parts.

For further information on Timken "Double-Zero" bearings, write The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED *This symbol on a product means its bearings are the best.*

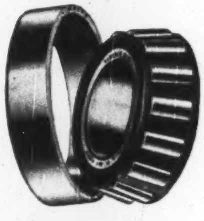
A PRECISION TIMKEN BEARING FOR EVERY REQUIREMENT

CLASS	"00" (DOUBLE-ZERO)	"0" (ZERO)	"3" (THREE)
RUN-OUT	.000075"	.000150"	.000300"
TYPES AVAILABLE	Standard Single Row	Standard Single Row	All types
SIZE RANGE	Up to 10" O.D.	Up to 12" O.D.	Up to 12" O.D.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST → ← LOADS OR ANY COMBINATION ✳